VARNISHES, LACQUERS,

PRINTING INKS AND SEALING-WAXES:

THEIR

RAW MATERIALS AND THEIR MANUFACTURE.

TO WHICH IS ADDED

THE ART OF VARNISHING AND LACQUERING, INCLUDING THE PREPARATION OF PUTTIES AND OF STAINS FOR WOOD, IVORY, BONE, HORN, AND LEATHER.

BY

WILLIAM T. BRANNT,

EDITOR OF "THE TECHNO-CHEMICAL RECEIPT BOOK."

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PREFACE.

THE object aimed at in the preparation of this volume has been to furnish the manufacturer as well as the skilled mechanic and amateur with detailed and reliable information regarding the preparation of fat and volatile varnishes, lacquers, printing inks, and sealing-waxes.

It is quite unnecessary here to enlarge upon the importance and commercial value of these products, since they are indispensable requisites both in the household and in the arts.

The quality of a varnish or lacquer depends almost entirely upon that of the ingredients, and, therefore, considerable space has been devoted to a description of the properties of the raw materials used, the chemical nature of which is, as a rule, but little understood. As a guide in the examination of the raw materials, simple methods for testing them have been given. In selecting these methods only such as can be executed without special chemical knowledge have been considered, while such as require the skilled hand of a trained chemist to give sure and satisfactory results have been indicated, without, however, entering into detailed descriptions.

In the preparation of printing inks and sealing-waxes many of the same raw materials used in the manufacture of varnishes and lacquers are employed, and, since the products are closely related to each other, these industries may be very well carried on together.

An appendix on the ART OF VARNISHING has also been added, included in which will be found a large number of valuable receipts for putties, stains for wood, bone, and ivory, etc.

Great care has been exercised in the selection of the receipts for the different groups of products, only the best and latest authorities having been resorted to, and a large number of volumes and journals consulted; and wherever different processes of apparently equal value for attaining the same end have been found, more than one has been introduced.

In regard to the use of the receipts the observance of the following rules is recommended: 1. Be careful to use the exact proportions prescribed. 2. Always experiment first with small quantities. 3. Should the first attempt prove unsuccessful, do not condemn the receipt, but make another trial, as the fault can generally be traced to a mistake in the manipulation, or an error in the quantities.

The various subjects treated of have, as much as possible, been arranged under special heads, but in a work of this kind a strict classification cannot be carried through. However, a very copious table of contents, as well as index, will render reference to any subject or special receipt prompt and easy.

In conclusion the editor takes pleasure in expressing his obligations to the enterprising publishers for the assistance rendered to him by a liberal supply of books and journals.

W. T. B.

PHILADELPHIA, June 17, 1893.

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VARNISHES, LACQUERS, AND PRINTING INKS:

THEIR RAW MATERIALS AND THEIR MANUFACTURE.

I.

INTRODUCTION.

THERE are few products of the chemical industry which find such universal use as lacquers and varnishes. They are absolutely indispensable to the mechanic as well as to the artist. We need only call to mind that the wood of our floors and furniture, many articles of leather, our carriages, the component parts of iron bridges, and other articles of metal exposed to the weather, are varnished or lacquered for the purpose of giving them a pleasing appearance or protecting them against atmospheric influences.

The old civilized races of eastern Asia—the Hindus, Chinese, but particularly the Japanese—are masters of the art of manufacturing varnishes and lacquers, they being far in advance of us in this respect. However, this is not due to the fact that they surpass us in chemical knowledge as far as it refers to this branch of industry; the excellent quality of their products must rather be attributed to the conscientious labor which marks all Japanese work and to the raw materials they use. They have at their command oils and resins furnished them from the rich storehouse of nature, many of which we do not even know, but which seem to be especially adapted to the manufacture of lacquers and varnishes.

It is next to impossible to draw a sharp line of distinction between varnishes and lacquers, the latter term being generally restricted to spirit varnishes and those compositions in which lac is the chief ingredient. A varnish, in the commonest acceptation of the term, consists of a resin of some description dissolved in a solvent which either readily evaporates or dries in the air, whereby the resin remains behind in a lustrous film. Varnishes prepared with fat oils are called fat or oil varnishes. They are without doubt the most valuable products, because, besides possessing considerable hardness and great lustre, they are very durable and resist atmospheric influences better than other varnishes. The oils most frequently used for these varnishes are linseed and walnut; the resins, chiefly copal and amber.

Varnishes prepared with a volatile solvent are usually called spirit varnishes, because formerly, besides oil of turpentine, spirits of wine was exclusively used as a solvent; but at the present time this term is no longer correct, and it would be more proper to designate these varnishes as volatile varnishes, because, besides spirits of wine, there are now used, as solvents, wood-spirit, benzine, petroleum-ether, and many other volatile fluids.

Although it is absolutely necessary that every manufacturer should have a thorough knowledge of the raw materials used in his branch of industry, this would seem, for two reasons, to be doubly necessary for the manufacturer of varnishes; for, on the one hand, the quality of his products depends in a higher degree on the choice of the proper raw materials than is perhaps the case in any other industry, and, on the other, the materials he has to use are frequently found in commerce in a badly adulterated state. For this reason considerable space has, in this treatise, been devoted to the description of raw materials and the modes of testing them as to their purity, the tests selected being, wherever possible, such as can be executed even by those not familiar with chemical manipulations.

Linseed oil forming the chief material for the manufacture of fat varnishes and printing inks, a full account of the most recent processes of purifying, bleaching, and boiling it is given.

II.

RAW MATERIALS.

THE materials used in the preparation of varnishes and lacquers may be divided into the following five groups:—

1. FAT OILS:
2. RESINS AND GUM-RESINS.
3. CAOUTCHOUC AND GUTTA-PERCHA.
4. SOLVENTS.
5. COLORING MATTERS.

For the production of satisfactory products, the utmost care in the selection of the raw materials is absolutely necessary. For this purpose the properties of the various materials must be understood, and a method for determining their purity be known. In the following treatise special attention has been paid to the latter point, and whenever possible methods of testing, which can also be executed by the non-chemist, have been given.

1. *Fat Oils.*

Oils are divisible into two groups, one of which includes those which dry up and harden, forming, by exposure to the air, a kind of elastic varnish. The oils of the other class do not harden, but become sticky and rancid in smell; these oils, however, if for some time submitted to the temperature of boiling water do in some instances become dry and hard, but the varnish they yield under these circumstances is dark in color and brittle. Our attention here is exclusively confined to the oils of the first group, which are generally known as *drying oils.*

In conformity with their chemical properties the drying oils must be classed with the large group of combinations known under the general term of fats. Generally speaking, fats are combinations of a base and several acids, and as chemists designate such combinations by the general term of *salts*, fats may be said to be salts containing several acids.

The base of most fats, and also of drying oils, is an oily body having a pungent sweetish taste. This is found in commerce under the name of *glycerin*, and, in a refined form, is chiefly used as a toilet article. Generally three acids are found in fats, namely: *stearic*, *palmitic*, and *oleic.* The first two of these form the material from which stearin candles are manufactured. In their purest state they represent foliated colorless crystals, which melt only at a temperature of over 140° F. Oleic acid is an oily, colorless, inodorous, tasteless fluid, clear as water, and does not redden litmus paper, either by itself or in alcoholic solution. It is insoluble in water, but readily soluble in alcohol and ether. It is a constituent of nearly all natural non-drying fats, which, as a rule, are the more thinly fluid the greater the quantity of oleic acid they contain.

Most fats, therefore, consist of combinations of glycerin with stearic, palmitic, and oleic acids. Such combinations are called glycerides, *i. e.*, compounds from which glycerin, on the one hand, and fatty acids, on the other, are obtainable. These glycerides are named after the fatty acids which they yield. Thus *olein* is the glyceride of oleic acid; *linolein*, the glyceride of linoleic acid. In reality three kinds or varieties of glycerides of each fatty acid are possible, but the oils used for the preparation of varnishes and lacquers almost entirely consist of one of these kinds.

Fats when exposed to the air for any length of time undergo a considerable change in regard to their properties. The originally colorless and tasteless mass acquires a very disagreeable odor and strongly acid taste; it assumes at the same time a darker color and becomes viscid. This change in the fats is called *rancidity*, and is caused by their oxidation, which progresses at first slowly, but later on more rapidly. The fats split first into free fatty acids and glycerin, and, by the absorption of oxygen, various volatile fatty acids (propionic, butyric, valerianic, caproic, and other acids) are formed from the free fatty acids and glycerin, imparting to the rancid fats their characteristic taste and odor. We would here call special attention to the fact that a fluid or non-drying fat *always remains fluid; it may become more viscid, but it never congeals to a solid mass*, even if exposed for years to the influence of the atmosphere. The drying oils, on the other hand, have, as previously mentioned, the property, under the influence of the air, of changing into solid masses of a resinous appearance, and it is this property which forms the only actually recognizable boundary line between the drying and the non-drying oils.

By a simple experiment, the so-called *elaïdin test*, it may readily be determined whether an oil belongs to the drying or non-drying oils. For this purpose put a few clippings or turnings of copper into a test glass, moisten them with moderately dilute nitric acid and pour the oil to be tested over them. The nitrogen dioxide (or nitric oxide) developed by the action of the copper upon the nitric acid passes through the oil, and converts the latter, if a non-drying oil, into a solid mass. *Drying oils remain fluid.*

Drying oils do not become rancid in the same sense as non-drying oils, though in drying they also acquire a disagreeable odor.

Light exerts a considerable influence upon the absorption of oxygen by the drying oils; while the process is in the dark very slow, it is most quickly accomplished in a blue or colorless light, and less quickly in a red, yellow, or green light.

Cloëz, who made the following observations, found that the weight of oxygen in ten grammes of poppy-seed oil increased

	In 40 days.	In 150 days.
In the dark . .	0.008 gramme.	0.638 gramme.
Colorless glass . .	0.520 "	0.798 "
Red " . .	0.322 "	0.726 "
Yellow " . .	0.471 "	0.733 "
Green " . .	0.307 "	0.786 "
Blue " . .	0.613 "	0.618 "

The process of drying does not take place in such a manner that the oil congeals to a hard mass at a certain moment, but by coming in contact with the air it thickens more and more, and gradually passes from a fluid into a solid state. But as, of course, this transformation also takes place when drying oils are exposed in an open vessel to the influence of the air, thus already introducing the drying process into the oil, it will be readily understood why, for instance, old linseed oil is dearer than that which has been recently pressed. The first, by having been in contact with the air for a considerable time, has already been transformed to such an extent that, when in this condition, it is spread out in a thin layer, it may actually be called a kind of varnish, as in a very short time it will form a solid coherent mass. On the other hand, fresh oil either must be stored for a long time or has to undergo a special treatment to acquire the property of drying quickly.

In the manufacture of varnish but a few of the drying oils are employed, the majority of them being produced in too small quantities to be of any importance for practical purposes. The oils most generally used are: *Linseed oil, poppy-seed oil, nut oil, hemp oil, castor oil, cotton-seed oil.*

A more general use of cotton-seed oil for the preparation of varnish is prevented by many difficulties; it may, however, be expected that on account of the enormous quantities of this oil which are produced, it will, in the future, be more generally employed.

It may here be appropriate to say a few words in regard to the general methods of extracting the oils from the seeds. There are two different processes in use. In one of these, which has been practised from very early times, the oil is obtained by pressure; in the other process, invented some fifty years since, the oil is extracted by means of an appropriate solvent. Although the yield obtained by the latter process is much greater in quantity, the oil is decidedly inferior to that obtained by pressure. It is less fluid, and contains a larger proportion of solid fat. The solvent commonly employed to extract the oil from oil-yielding materials is carbon disulphide (CS_2), a compound of carbon and sulphur, which may be prepared cheaply by passing the vapor of sulphur through red-hot charcoal. Of the process for obtaining oils by pressure there are two modifications. In one of them, which is more usually adopted, the oil seed or other material is first heated and then pressed while still hot. In the other the pressure is applied to the cold seed. Cold-pressed oils remain clear in cold weather, are more fluid than hot-pressed oils, and contain a smaller proportion of solid fats and of free fatty acids.

Linseed oil.—For the manufacture of varnish linseed oil is the most important material. It is obtained from the seed of the common cultivated flax (*Linum usitatissimum*). Linseed varies in size and color. The usual colors are a purplish-brown and a reddish-brown, but in some parts of the northwest provinces of India, especially in Nagpur, there is also found a nearly white variety. Of the common or brown linseed, the chief supplies come from Russia and India. The seed as brought from Russia and India contains much dirt, and other oil seeds, such as mustard, rape, and non-oily weed seeds. In fact it is said that some growers of the plant purposely cultivate other plants and weeds on the same ground, whence all the seeds being gathered together form a quick means of adulterating the linseed. The presence of foreign oil seeds is very objectionable, since most of them contain non-drying oils which mingle with the linseed oil and deteriorate its quality.

Linseed contains, on an average, 30 to 35 per cent. of fat drying oil in the kernel and 15 per cent. of a mucilaginous body in the hull. This mucilaginous body is of an acid nature and readily dissolves in water. From the aqueous solution it may be separated in the form of white flakes by spirits of wine or by solution of subacetate of lead, a somewhat more dense white precipitate being obtained in the latter case. In pressing linseed a portion of this mucilaginous body passes into the oil and thus forms an admixture which is not exactly desirable for the manufacture of varnish; however, as shown above, this mucilaginous substance can be readily removed.

In commerce three kinds of linseed oil are distinguished, according to the method of preparation, viz: *Cold-drawn* or *cold-pressed oil*, *hot-pressed oil*, and *oil extracted* by means of carbon disulphide or other readily volatile agents.

The oil prepared by cold pressure is the finest and best. It is of a golden-yellow color, and has a peculiar but not disagreeable taste and odor. In Russia and some parts of Germany it is used as a table oil. In order to obtain the oil as free as possible from mucilage, the seed should be kept three months before being pressed. By cold-pressing, the seeds yield from 20 to 21 per cent. of oil.

The oil prepared by hot-pressing is somewhat darker than the preceding, but still of satisfactory quality. It is amber-colored or brown-yellow, and has an acrid taste due to traces of volatile fatty acids, such as butyric, valerianic, and caproic. It is extensively used in paints, printing inks, varnishes, etc. An oil of a very good quality is obtained if, in pressing, the temperature is not allowed to exceed 194° F.

The oil extracted by means of carbon disulphide is the least suitable for our purposes. It is of a dark brown color, and when viewed with the light falling on it from above, shows a greenish fluorescence, a proof of its having absorbed sulphur from the carbon disulphide. It is this content of sulphur which renders the use of such oil inadmissible for the manufacture of varnishes produced with the assistance of lead combinations, they acquiring thereby a deep dark color. By extraction with carbon disulphide, linseed yields 32 to 33 per cent. of oil. The oil extracted with the assistance of other solvents, such as benzine, naphtha, etc., though better as regards color than that extracted with carbon disulphide, is nevertheless objectionable on account of the intense odor of the above-mentioned solvents, which so tenaciously adheres to it that it can scarcely ever be completely removed.

A good quality of linseed oil should possess the following qualities: A golden-yellow to brownish-yellow color and a mild taste even when hot-pressed.

The specific gravity of good linseed oil at 60° F. is 0.935; a bottle which will hold 1000 grains of water at this temperature will, therefore, hold but 935 grains of linseed oil. It expands considerably with heat, its specific gravity at 50° C. being 0.913 only. At 59° F. the oil is 9.7 times more thickly fluid than water, and at 45.5° F. 11.5 times. At a decreasing temperature it becomes gradually thicker, becoming pale and turbid with increasing cold, and congeals to a solid yellow mass at —16.5° F. At 266° F. it commences to boil, and after boiling for some time at from 482° F. to 554° F., until it has lost about one-twelfth of its weight, it becomes thicker, viscous, and sticky, and furnishes varnish. By heating it still further, until it has lost one-sixth of its weight, it becomes still thicker, the product being printing ink.

By heating linseed oil to from 608° F. to 707° F. it ignites and burns quietly without further external heating until tar and carbon remain. By covering the boiler and thus interrupting the burning there remains a brown, turpentine-like substance, the so-called bird-lime.

Linseed oil is soluble in 1.5 parts of ether, in 40 parts of 90 per cent. alcohol, in 5 parts of boiling 90 per cent. alcohol, and in 5 parts of absolute alcohol. It is miscible in all proportions with chloroform, carbon disulphide, oil of turpentine, etc.

The elementary composition of linseed oil is as follows:—

	Cold-drawn.	Hot-pressed.
Carbon . . .	78.11 per cent.	75.27 per cent.
Hydrogen . . .	10.96 "	10.88 "
Oxygen . . .	10.93 "	13.85 "
	100.00 "	100.00 "

Linseed oil is a mixture of linolein (the glyceride of linoleic acid)—which forms the principal constituent, or about 80 per cent.—olein, palmitin, and myristin.

For the varnish-maker the most important chemical property of linseed oil is its behavior with oxygen. To summarize the chemical changes induced in linseed oil by exposure to the air, it may be said that the oil dries, or, in other words, that it passes, by mere absorption of the oxygen of the atmosphere, from a fluid into a solid state. The changes which occur during this oxidation are complex and ill-understood, but there is some formic acid formed, so that the product is acid; carbonic acid gas and water are also produced.

There are many ways of bringing about this oxidation; a very common one being to heat the oil to a temperature of at least 212° F. and to blow air or air containing ozone through it. Various substances favor the absorption of oxygen by linseed oil, amongst which may be named manganese dioxide, borate, oxalate, or lineolate; red lead, litharge, or lead acetate; green vitriol or white vitriol, etc.

The principal reasons for boiling linseed oil are two: First, that drying may be facilitated when the oil is spread upon thin surfaces, either alone, or when mixed with coloring-matters; and, secondly, that it may serve as a vehicle for the mechanical suspension of the finely divided particles, thus enabling them to adhere to the surface on which they are spread. It must not run into drops nor must it leave the coloring-matter behind. The color must be carried by it—evenly diffused over the whole surface. The object to be attained is to secure a coating impervious alike to liquids and gases.

It may happen even when the process of boiling has been performed properly and with the utmost care that the result may prove unsatisfactory to the consumer. This may sometimes be traced to circumstances entirely independent of the process of manufacture. The quality of the seed—green or ripe, new or old—the climate and the soil in which the seed was grown, all exert a marked influence upon the product. The different varieties of seed call for separate and distinctive treatment.

All oil-boilers should test the drying qualities of each batch of oil. One tried and approved test is to dip into the oil, when cool, a piece of well-sized paper, which is afterwards hung up to dry. Thoroughly well-boiled oil will produce a crystalline surface over nearly the entire portion of the paper dipped in the oil. If the boiling has been imperfect the upper portion of the surface of the paper will simply be greasy and only the lower portion will show the varnish coating. When the submerged portion of the paper is touched with the finger and no grease adheres to the latter, the boiling may be said to be complete.

Adulterations of linseed oil and their detection.—A very frequently occurring admixture of linseed oil is the fat oils of mustard, rape, etc., the seeds of the latter plants being, as a rule, present in the linseed used for pressing. For the manufacture of varnish a small content of fat mustard seed oil is not of great importance, but a larger quantity may, under certain circumstances, injure the property of the varnish of drying rapidly. A larger content of fat mustard-seed oil may be detected by the oil showing a yellowish crummy precipitate after standing for several days in a moderately warm room (50° to 54° F.). A content of fat mustard-seed oil may be still more accurately determined by the elaïdin test given on p. 7; a separation of elaïdin in a few days being obtained, while pure linseed oil does not congeal even if standing for some time. An admixture of rape oil is also detected by the same test.

Valenta's acetic acid test may also be readily managed by an experimenter who is not a skilled chemist. To apply this test, take equal volumes, 3 cubic centimeters of each, of the oil and of glacial acetic acid (specific gravity 1.0562), mix thoroughly and gradually, heat the mixture until the oil has completely dissolved, or the boiling-point is reached. Immerse a thermometer in the liquid, allow the latter to cool slowly, and note the temperature at which cloudiness appears. The following temperatures are those at which this turbidity is produced in the case of several different oils.

Name of oil.	Temperature of turbidity.
Niger seed	120.2° F.
Linseed	134.6° "
Sesame seed	224.6° "
Almond	230.0° "
Ground nut	233.6° "

Rape seed, mustard seed, etc., not dissolved.

From the above figures it will be seen that of the six oils given, linseed oil is, with one exception, the most soluble; and that the presence of such usual impurities as the oils of sesame, rape, and mustard tends to reduce the solubility and hence to develop turbidity in the acetic acid sooner—that is, at a higher temperature.

The specific gravity of linseed oil also affords a valuable means of testing its purity. At 60° F. it is denser than most other vegetable oils:

Name of oil.	Spec. Grav.	Name of oil.	Spec. Grav.
Linseed	0.935	Poppy seed	0.926
Gold of pleasure	0.931	Sunflower seed	0.925
Hemp seed	0.930	*Black mustard seed	0.921
Cotton seed	0.930	*Ground nut	0.918
Walnut	0.929	*Colza seed	0.914

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* The three oils marked with an asterisk are non-drying oils.

Resin and resin oil are *intentional adulterations* of linseed oil. The former is detected by continuously shaking a sample of the oil with 85 to 90 per cent. alcohol, and then allowing the fluid to clear. When the fluid is clear separate the alcoholic solution from the oil and add to it a solution of acetate of lead; if *resin* is present, an abundant white precipitate is formed.

The *detection of resin oil* is somewhat more difficult. Heat 5 grammes of the oil to be tested with 2 or 3 grammes of caustic soda and 30 to 40 cubic centimeters of water upon a water bath, then add about 1 gramme of bicarbonate of soda, and after further adding a small quantity of sand previously thoroughly washed and glowed, heat the whole to dryness. Extract the dry residue with ether or petroleum-ether, and free the combined and filtered extracts in a weighed flask from the volatile solvent by carefully placing the flask in cold water. The residue left behind consists of resin oil, and is weighed. Mineral oils are detected in the same manner.

A simple method of detecting adulteration with resin oil is to rub a drop of the oil to be tested between the hands. If resin oil is present, a distinct odor of resin will be perceptible.

The quality of linseed oil may also be tested by covering the bottom of a small plate with a thin layer of the oil and placing the plate in a warm place (about 105° to 175° F.). If the oil is good, it will so dry in about three days that it is not sticky when touched with the finger.

Purification and bleaching of linseed oil.—The linseed oil found in commerce contains, as a rule, a considerable quantity of foreign substances, such as water, linseed-meal, etc., which, if the oil is to be used for varnishes, have to be removed in order to produce a faultless product.

The simplest and least expensive method of clarifying and purifying the oil is to allow it to rest for a sufficient length of time in a large vessel of wood, stone, or iron. To admit the access of air, the vessel should be open on top, or, where this is not possible on account of dust, it should be provided with apertures near the upper edge. It should also be provided with discharge cocks at various distances above the bottom. However, this process is slow and requires considerable storage room. Hence, in many cases it will be necessary to employ mechanical means for purifying the oil. To such mechanical means belong—

1. Machines in which the oil is kept in constant motion for some time and then allowed to rest.

2. Contrivances by which the oil is caused by its own gravity or artificially produced pressure to flow through impediments which retain the mechanical impurities (filtration).

3. Heavier fluids than oil which, after being thoroughly mixed and worked with the latter, are allowed to rest and take up the impurities, so that the separation takes place more readily.

4. Heating the oil and forcing through it atmospheric air at an increased temperature.

These mechanical means have proved more advantageous than chemical agents, the separation of the latter from the oil and washing with water until complete neutrality is obtained being one of the most difficult and time-consuming operations. Washing is absolutely necessary, because the acids, salts, etc., remaining in the oil might injuriously affect its color. Furthermore, considerable time is required to get the oil perfectly clear and transparent; and in addition, losses are incurred by the oil not separating entirely from the layer of water containing the salts or acids, a layer of saponified oil being formed. To obtain the oil from the latter, extraction with ether becomes necessary.

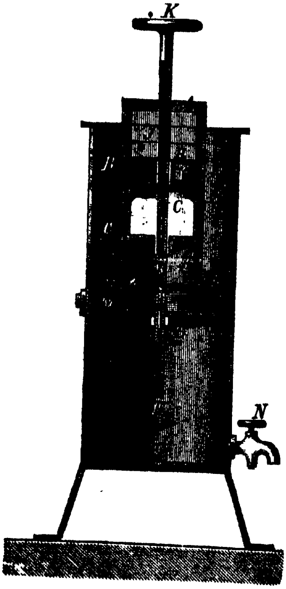
For the sake of completeness, the chemical methods of purifying oil, however, will also be given.

For small establishments it is more advantageous to clarify the oil by allowing it to rest for some time than to use chemical means. For working on a large scale one of the contrivances described below may be recommended, and especially that given under 4 (p. 17), which allows of rapid and continuous working.

Mechanical contrivances for the purification of oils.—Fig. 1 shows the oil-purifying machine constructed by Otto Rieck, of Mühlheim. *A* is a cylinder which widens towards the bottom and is secured in the reservoir *B*. *C* is a hollow piston with reticulated bottom; it fits tight in the cylinder, but can readily be moved. *D* is a hollow piston rod which is firmly connected with the piston. At *E* it passes through a stuffing-box and reaches into the lower reservoir. *G* is a reticulated piston cover which can be pressed by means of the metallic screw *H* upon the filtering mass in the piston. *J* are weights for regulating the pressure of the piston. *K* is a hand-wheel for drawing up the piston, *M* the cleaning hole, and *N* a cock.

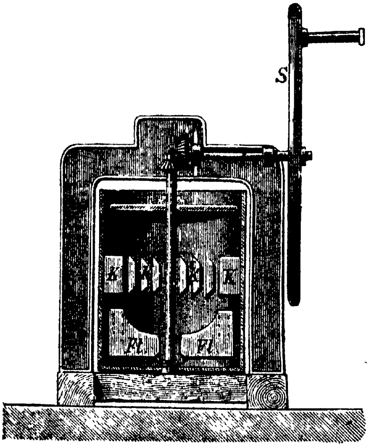
The apparatus works as follows: The oil to be purified is poured into the reservoir *B* and the piston drawn up by means of the hand-wheel *K*, in consequence of which the oil passes through the valve into the cylinder below the piston. The piston, suitably loaded with weights, now sinks slowly down, whereby the oil is forced from below to above through the filtering mass, passes over the piston cover, and flows through the aperture in the hollow piston rod into the lower reservoir. The dirt from the oil is removed through *M*.

Fig. 1.



Cataract oil-purifying machine.—This machine is shown in vertical section in Fig. 2. The oil to be purified is poured, up to a mark, into the cylindrical iron vessel. By revolving the fly-wheel *S* the wings *Fl* are set in rapid rotation. In consequence of the action of the centrifugal force, the oil rises on the sides

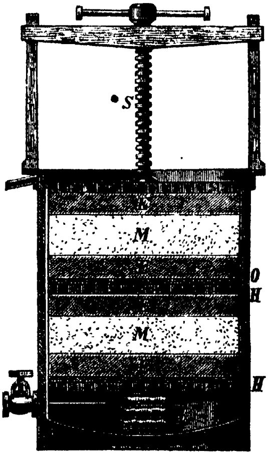
Fig. 2.



of the vessel, is turned aside by the plates *KK* and a ring above them, and falls down in the centre. The oil thus makes a circuit, and during this circuit such an intense mixture and violent motion, and at the same time such intimate contact with the atmospheric air, take place as cannot be attained by another machine or in any other manner. Hence, this machine is especially well adapted for the purification of oil, and may also be used for mixing varnishes and lacquers with coloring-matters. It is manufactured at Varel, Oldenburg, Germany.

Oil filter.—Felt bags were formerly in general use for filtering oil, but they had the disadvantage of becoming quickly and repeatedly clogged with solid matter, and cleansing the bags was very tedious. Later on vats with conical openings in the bottom stopped with cotton plugs were used, but they would also choke up and become impermeable to the oil. Though this process is still used in some refineries, a much better method is to pass the oil through a filter working only with linen, tow, and moss. Such a filter is shown in Fig. 3.

Fig. 3.



The iron filter box, lined with lead, is fed from a basin placed at a higher level. On the bottom of the filter is the cross-beam *H*, carrying a perforated wooden plate covered with a layer of coarse and one of somewhat finer linen, *O;* then follows a thin layer of tow, *E*, and upon this a layer of moss, *M*, and linen; then again, a wooden plate, and so on in the order mentioned. The screw *S* not only assists in packing the filter, but the filtering operation itself can be regulated by tightening or loosening it.

Moss (*Hylocomium triquetrum*, Schimp., *Hypnum splendens*, Hedw., *Polytrichum commune*, L.) is especially adapted for the purification of oil. In using it by itself for packing the filter an arrangement for convenient compression must be provided. The packing must be renewed about every three weeks. The material no longer fit for use is subjected to strong pressure to obtain the oil and then treated with hot water.

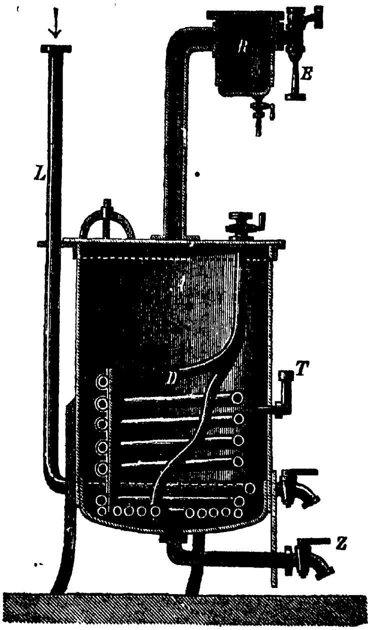
Oil-refining boiler.—The oil-refining boiler, Fig. 4, is a more recent apparatus, and turbid oils treated in it in a short time become bright.

The boiler *A* is provided with the serpentine pipe *D*, which proceeding from the lid returns to it after many turnings. In the lid is fitted a pipe carrying a vessel *R* with the air ejector *E*. This ejector produces in the beginning of the operation a *vacuum* in the upper part of the boiler filled about two-thirds with oil.

When the *vacuum* becomes greater fresh atmospheric air enters through the pipe *L*, and produces a lively motion in the oil heated by the pipe *D*. By the motion of the oil and the high temperature, the water mechanically fixed is removed and a chemical effect exerted upon the oil by the oxygen of the air.

Oil treated with this apparatus is as bright and clear as if it had passed through all the refining processes. Steam may also be introduced into the apparatus. The precipitates formed deposit rapidly on the bottom and can be removed through the cock *Z*. The water then present is readily evaporated by adjusting the ejector.

Fig. 4.



The action of the ejector is so powerful that the temperature is increased as much as 50° F., and can be measured by the thermometer *T*, which passes into the boiler and is required for various purposes.

Chemical purification of linseed oil.—For purifying linseed oil, sulphuric acid, hydrochloric acid, alum, common salt, potassium chromate, potassium permanganate, etc., are used.

For 300 to 400 lbs. of linseed oil about 1 lb. of fuming sulphuric acid (oil of vitriol) is used. The acid should be added in a thin jet with constant stirring. After thorough stirring add one-third the quantity of the oil, of boiling water, stir thoroughly and allow to settle. After the complete separation of the acid water from the oil, draw off the oil into another barrel and add 3 per cent. of finely pulverized common salt. The salt withdraws from the oil the water still adhering to it. The oil is finally filtered through bags filled with wheat bran. The oil after having been thoroughly worked with sulphuric acid should not immediately be treated with water, but be allowed to stand quietly over night. The next day the oil can be drawn off clear and pure, the slime remaining on the bottom of the vessel. Now dissolve for every 200 lbs. of oil, ½ lb. of common salt in 10 quarts of water, pour the solution, which should be as hot as possible, into the oil, and stir for 1 to 2 hours, or until a delicate white foam has formed upon the oil. This foam is a good sign, but also indicates that stirring must be stopped, otherwise the oil becomes thick and dirty and does not clarify. By now allowing the oil to stand in a moderately warm place for about two days it separates perfectly bright and clear. It is then filtered through dry river sand, previously thoroughly washed, or through felt bags.

According to Evrard, oil may be purified by shaking it with a thin solution of potash or soda, drawing off the non-saponified oil, shaking with water, and again allowing to settle.

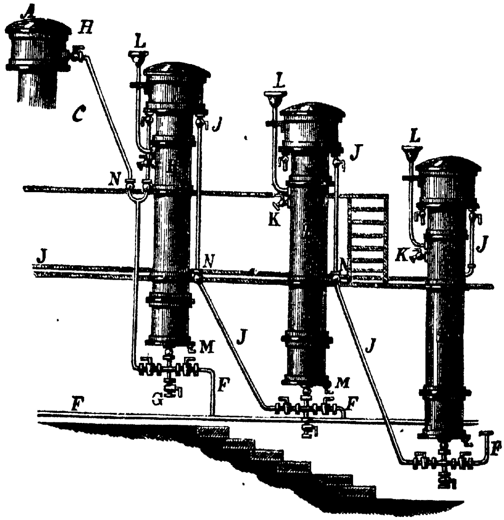
In place of sulphuric acid, Wagner proposes the use of a concentrated solution of chloride of zinc, which does not act upon the oil, but destroys the impurities. For 100 parts by weight of oil 1½ parts by weight of chloride of zinc solution of 1.85 specific gravity are used.

Another very advantageous and comparatively rapid method of purifying linseed oil is by means of potassium permanganate, which at the same time produces a bleaching effect. For the purification of 100 parts by weight of linseed oil, prepare a solution of 1 part of crystallized potassium permanganate in 30 parts of distilled water at the ordinary temperature. Add the solution to the oil to be purified, stirring constantly. Then agitate the mixture for two hours more, and finally allow it to rest. In the course of one or two days the oil has separated from the potassium permanganate solution. It is now free from all foreign admixtures and also somewhat paler. It is finally drawn off into another barrel.

The Raymond-Combret apparatus.—This apparatus allows of a combination of the chemical with the mechanical process of purification, the oil being purified by passing it in fine jets through different acid or salt solutions.

The purification is effected in the cylinder *B*, Figs. 5 and 6, of which there are several to make the operation a continuous one. The oil is placed in the reservoir *A*, and passes through the pipe *C* and the rose *D* to the iron cylinder *B*, which is tinned inside. The cylinder has a somewhat larger diameter near the top. It is filled with water and closed with a lid. The pipe *C* conducts the oil to the pipe *E*, which is connected with the steam-pipe *F*, by means of which the purifying liquid can be heated. The pipe leading downwards and connected with the cock *G* serves for cleaning the pipe *E*. Through the pipe *C* and the rose *D*, the oil enters the cylinder in a uniform manner, passes through the column of water or a column of liquid containing various acids or salts, and collects at the top.

Fig. 5.



The cock *H* serves for the direct discharge of the oil, while the cock *J* conducts it into the next cylinder or the filtering apparatus.

The level of the water in the cylinder can be exactly brought to the height of the cocks *H* and *J* by discharging water through the cock *K*, or by admitting it through the pipe *L*.

The cylinder *B* is emptied through the cock *M*. In arranging several cylinders they must be so placed that the bottom of the upper wider portion stands somewhat higher than the next one, so that the oil can flow by its own gravity from one vessel into the other, thus passing through all the cylinders and reaching the filtering apparatus from the last one through the pipe *J*.

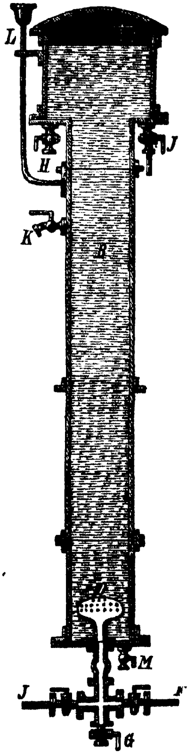
It is of great advantage to place small rotary pumps *N* in the pipes *J* and *C* to increase the velocity of the flow of the oil to the cylinder, and if necessary to reconduct the oil through the pipe *O* to the bottom of the same cylinder.

By this method it is possible to use various chemical substances employed in the purification of oil, such as sulphuric acid, solutions of chromates, manganates, etc., according to the effect which is to be produced.

Fig. 6 shows the purifying cylinder in cross-section.

Bareswil's method of purification.—This method is based upon an incomplete saponifica-

Fig. 6.



tion. The oil is compounded with two to three per cent. of quicklime or caustic soda lye, and the mixture gradually heated. The soap separated forms a stiff lather, enveloping the foreign substances, which become insoluble and are deposited, together with the soap, on the bottom. The supernatant clear oil is separated by pouring off and filtering through linen. The residue is used in the manufacture of soft soaps.

Experiments in clarifying oil by a centrifugal machine, which have recently been made by Mayer, have given very favorable results. The oil as it comes from the press is directly conducted to the centrifugal machine, which effects in a short time the separation of the mucous and albuminous substances, residues, etc., they forming a consistent deposit on the periphery of the centrifugal drum. Besides the advantage of quick work, this method gives a greater yield of pure oil than purification in vats, as the consistent residues contain less oil, and the cleansing of the centrifugal drum is less troublesome than that of the vats.

Bleaching of linseed oil.—For certain purposes, especially for the manufacture of quite pale varnishes and delicate paints, the linseed oil purified by one of the above described processes, requires bleaching in order completely to remove its somewhat yellowish color.

The oldest and simplest method of freeing oil from coloring-matter is based upon the action of light and air, which might be called the "natural or sun process" as distinguished from the "chemical or quick process," which was first introduced in 1786 by Berthollet. He used chlorine, discovered by Scheele, which since then has, however, been supplemented by other agents.

Generally speaking, light acts chemically by re-separating oxygen from various substances or by promoting the combination of the atmospheric oxygen with the hydrogen and carbon of the organic substance, *i. e.*, the coloring substances, whereby the latter are frequently entirely decomposed or changed to a lighter hue. In many cases the actual effect of light may be due to the fact that under certain conditions it promotes the formation of ozone or of peroxide of hydrogen, which oxidizes coloring-matter with greater ease than the ordinary oxygen of the air. Sunlight is, of course, the most powerful bleaching agent.

For bleaching larger quantities of oil by means of light, especially sunlight, lead boxes or wooden boxes lined with zinc are used. It is best to have the boxes about 3½ feet long, 1¾ feet wide, and 5¾ to 7¾ inches deep. They should be provided with well-fitting lids, in each of which is inserted a large pane of glass. Another necessary condition in bleaching is a supply of air. For this purpose the sides of the boxes are provided, immediately below the lid, with holes opposite to one another. In these holes tubes are inserted so that a constant current of air passes over the surface of the oil. By these means the oil will, in about 14 days, become perfectly white and clear so that it can be drawn off. The sediment may be added to ordinary oil. To effect rapid bleaching chemicals are occasionally added to the oil, a small addition of 96 per cent. alcohol being, for instance, very advantageous. The oil is also frequently compounded with sulphate of lead or solution of ferrous sulphate (green vitriol, copperas).

Bleaching with sulphate of lead.—Sulphate of lead is a white insoluble powder which may be readily prepared by combining sulphuric acid with acetate of lead (sugar of lead). For bleaching linseed oil, mix for every 100 parts of oil to be bleached 2 parts of sulphate of lead with a small quantity of oil. Thin down the mixture to the consistency of milk and add it to the linseed oil. By exposure to light the turbid fluid slowly clarifies, and in a few weeks the oil will be found perfectly clear and bleached. The foreign substances which were contained in the oil lie in a quite solid mass over the sediment of sulphate of lead, which may be repeatedly used for the same purpose.

Bleaching with ferrous sulphate (green vitriol, copperas).—Prepare a solution of green vitriol by dissolving 220 lbs. of ferrous sulphate in 42 gallons of water. Have ready a number of glass bottles of about 4 gallons capacity each. Bring into each bottle about 22 lbs. of the oil to be bleached, and add 4 to 5 quarts of the ferrous sulphate solution. Place the bottles in a room in such a manner that they are exposed as much and as long as possible to the direct rays of the sun. Every bottle should be well shaken at least once a day. It takes from three to six weeks perfectly to bleach the oil. The length of time will depend on the temperature, but especially on the stronger or weaker effect of the rays of the sun.

Besides, by means of sunlight, oils are very quickly bleached in a room holding air containing ozone, which is produced by means of electricity or by placing moist sticks of phosphorus in the room.

Peroxide of hydrogen, which is now manufactured on a large scale, and brought into commerce in a 10 per cent. solution, is well adapted for bleaching oils, it being only necessary frequently to agitate the oil to be bleached with the solution. Bleaching is effected in a few days, the oil clarifying rapidly, so that its separation from water by means of a siphon is readily accomplished. According to the degree of coloration, 5 to 15 per cent. of the 10 per cent. solution of peroxide of hydrogen suffices for bleaching linseed oil.

The bleaching of oil by treating it with potassium permanganate and sulphuric acid is based upon the action of ozone. The process is conducted in wooden vats lined with lead and provided with a stirring apparatus and heating pipe. Solution of chromate or permanganate of potassium strongly acidulated with sulphuric acid is gradually added to the oil with constant stirring, and the stirring continued one-half to one hour, though frequently the process is finished sooner. After resting six to twelve hours the oil has clarified over the greenish or brownish fluid which contains chrome alum or manganese alum. The acid fluid is then drawn off, the oil washed two or three times with warm water and allowed to rest. The clarified oil is then removed. An emulsive layer remains between the aqueous layer and the clear oil. By compounding this emulsive layer with 10 to 15 per cent. petroleum-ether an immediate separation is effected. When after several bleachings sufficient material to fill a still has been obtained, the petroleum-ether is regained by distillation, and employed for further operations.

For 220 lbs. of oil about ½ to ⅝ lb. of potassium bichromate or potassium permanganate is used, and double the quantity of sulphuric acid previously diluted with 5 or 6 times the quantity of water.

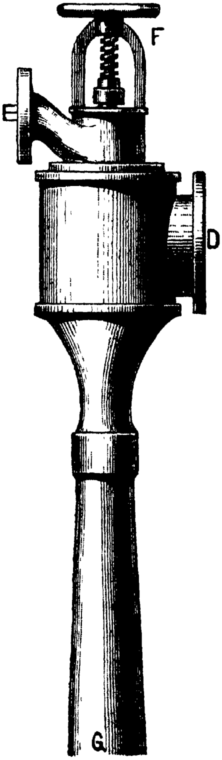
The same object is attained by mixing 220 lbs. of oil with about 2 pints of sulphuric acid previously diluted with about 7 to 8 gallons of water, and gradually adding to the heated mixture small portions of very finely pulverized pyrolusite until the mass, at first black, becomes white. After completion of the operation the oil is washed and further treated as above described.

For bleaching with chlorine, chlorine is either developed as such, or as a combination in the form of potassium or sodium hypochlorite; the first known as *eau de Labarraque*, and the latter as *eau de Javelle*, being used. These solutions should contain no free sodium carbonate originating from their preparation, as otherwise an emulsive mixture difficult to separate is formed. Linseed oil frequently agitated with these solutions is thoroughly bleached, but the oil retains a peculiar chlorine odor, which, however, can be almost entirely removed by adding to the second wash water a small portion of hydrochloric acid. The latter must, of course, be removed by a third washing.

For bleaching large quantities of oil with chlorine, wooden vats provided each, with a wooden stirring apparatus and a heating pipe coated with rubber or tar are used. The chlorine is developed from hydrochloric acid by the addition of substances rich in oxygen, such as potassium permanganate, sodium hypochlorite, and calcium hypochlorite. Two hundred and twenty parts by weight of oil are first mixed with 2½ to 5 parts of crude hydrochloric acid previously diluted with four times the quantity of water; ¾ to 1 part of the above:

mentioned salts rich in oxygen is then gradually added. Or the process may also be carried on in a reverse order by first mixing the solution of the salt with the oil, and then gradually adding the hydrochloric acid in small portions. In using *eau de Javelle*, or solution of chloride of lime, 1 part by weight of it is allowed for 1 part of hydrochloric acid.

Fig. 7.



The principal objection to the use of chlorine is that it attacks the oil very vigorously by readily decomposing stearic acid, and an excess of chlorine, which can never be entirely avoided, must, therefore, injure the quality of the oil. For this reason bleaching with chlorine cannot be recommended.

For bleaching with sulphurous acid the cheap commercial sulphite of soda, $NaHSO_3$, is used. A good result may be produced by agitating the oil with a concentrated solution of the salt, but to obtain the effect of all the acid in the solution it is compounded with dilute sulphuric acid. Vats lined with lead are used. One to one and a half parts by weight of sulphite of soda suffice for 220 parts of oil. Here, also, care must be taken to add the sulphuric acid gradually until it is slightly in excess, as by adding too much of it at a time the development of sulphurous acid takes place too vigorously, and the acid escapes without producing any effect.

Koerting's air-suction or steam-jet suction apparatus is well adapted for bleaching oil with sulphurous acid.

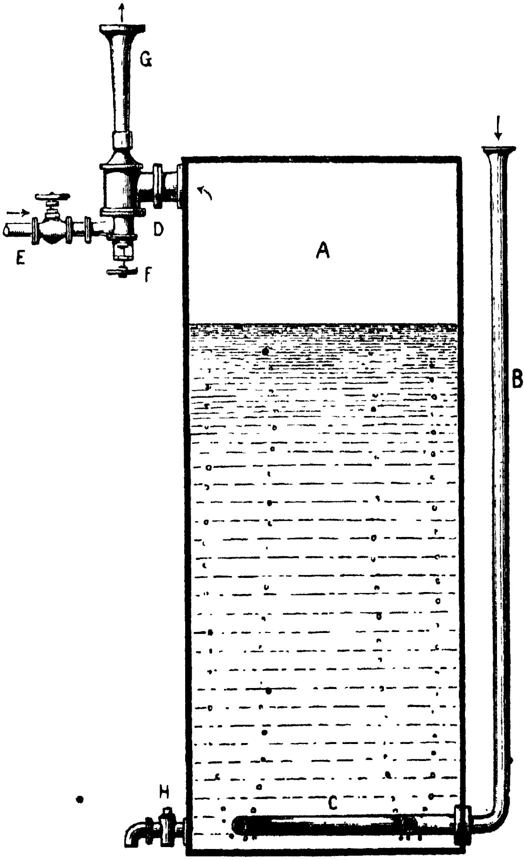
The steam-jet suction apparatus, Fig. 7, manufactured for this purpose of lead, acts by steam entering the apparatus through the pipe *E* and passing in the interior through a series of conical nozzles. In passing these nozzles the exterior air is very rapidly sucked in through *D* and expelled through the opening *G*.

The steam-jet suction apparatus will act as wanted, either by suction or pressure, and, therefore, rarefy or compress the air as may be required. It is so constructed that with a tension of three atmospheres of steam it will with suction overcome the pressure of a column of water of 10 to 26 feet, and with pressure one of 10 to 13 feet.

In Fig. 8 the air-suction apparatus is placed on the top of the vessel containing the oil to be bleached. Through the pipe *B* and the perforated worm *C* sulphurous acid in a very finely divided state is sucked through the oil until the latter is bleached. The vessel must, of course, be hermetically closed.

The sulphurous acid used for bleaching is developed by burning sulphur under admission of air in an oven of simple construction. To regulate the process the introduction of steam may be increased or decreased by the valve *F*.

Fig. 8.



The apparatus is very effective, and can also be used for somewhat thickly-fluid fat, provided it is not too pasty.

The oil bleached by means of sulphurous acid is washed in the manner previously described.

Poppy oil.—This oil is obtained from the seeds of *Papaver somniferum*, Linn., the opium poppy. Two varieties are cultivated, *Papaver album* and *Papaver nigrum*, the first bearing white seeds, which are principally used for medicinal purposes and yield a finer oil than *Papaver nigrum*, with bluish-black seeds. The percentage of oil is the same in both varieties, varying between 50 and 60 per cent.

The seeds are first pressed cold, whereby an oil of a slightly yellowish color and a delicate agreeable taste is obtained. By cold pressure 33 to 40 per cent. of oil is obtained. The seeds are then subjected to hot pressure, the resulting oil being of a pronounced yellow color and having an acrid taste and strong odor. The specific gravity of poppy oil at 60° F. is 0.926, and if the fluidity of water be represented by 1000 that of poppy oil at 60° F. is 74. Its chemical composition is near that of linseed oil. It contains the same four glycerides, but in different proportions, for it is mainly made up of linolein and olein.

Exposed in a thin layer to the air poppy oil dries somewhat more slowly than linseed oil. By treatment with litharge or solution of acetate of lead, it is readily converted into a useful varnish. It is chiefly used in the fabrication of fine qualities of lacquers and varnishes. It is also used by artists for thinning their colors.

Poppy oil does not freeze readily, it remaining clear and thickly-fluid at 5° F. and solidifying to a thick white mass only at —4° F. It is soluble in equal volumes of ether, in 25 parts of cold and in 6 parts of boiling alcohol.

Adulterations of poppy oil.—The simplest test of poppy oil is by taste and odor, and allowing a few drops to dry upon a glass plate in a water-bath or in a warm place. The dried residue should be clear and hard, and not viscous.

For the detection of an admixture of other oils, the elaïdin test described on page 7 may be used. Poppy-seed oil is not changed by this test, it remaining fluid.

Nut oil.—This oil is obtained from the kernels of the common walnut, *Juglans regia*, Linn. The nuts used for oil should be at least two or three months old, the fresh kernels containing a kind of emulsion (milk) and yielding a turbid oil difficult to clarify. The kernels, which contain from 40 to 50 per cent. of oil, are separated from the shells and skins, crushed, and pressed. After the cold-drawn or "*virgin*" oil is obtained, the residue is pressed with the assistance of heat. The yield from the first pressure amounts to from 30 to 35 per cent., which is chiefly used as table oil, and from the second to from 10 to 15 per cent.

Fresh cold-drawn nut oil is thinly fluid, almost colorless, or pale greenish-yellow, and has an agreeable taste and odor. It soon gets rancid, and in that condition possesses purgative properties. Warm-pressed oil has a darker color and a peculiar acrid taste and odor. The specific gravity of cold-drawn oil is 0.9250 at 59° F., and that of warm-pressed oil 0.9268 at the same temperature.

Nut oil is 9.7 times more thickly-fluid than water at 59° F. It remains thinly-fluid at 5° F., commences to thicken at 1.5° F. to —0.5° F., and congeals to a solid white mass at —16.5° F. to —18.5° F.

One hundred volumes of cold alcohol are incapable of dissolving 1 volume of nut oil, while 60 volumes of hot alcohol dissolve 100 volumes of it. Cold ether dissolves an equal volume of the oil.

The chemical composition of nut oil is nearly that of linseed oil, the constituent glycerides being the same in kind, but a larger proportion of linolein is present.

Nut oil dries even more readily than linseed oil, and for that reason is preferred for fine oil-painting. It gives varnishes which, on account of being entirely colorless, are in much demand for delicate pale colors.

Adulteration of nut oil.—The principal adulteration of nut oil is with bleached linseed oil. Such adulteration is readily recognized by the viscous, resinous mass which is formed by heating the oil to be tested to from 608° F. to 707° F., when it ignites, and allowing it to burn quietly without further external heating.

Other tests are the same as given for poppy oil.

Hemp oil.—This oil is obtained from the seeds of *Cannabis sativa*, Linn., the common hemp. The seeds contain from 30 to 35 per cent. of oil, which also belongs to the readily drying oils. By pressure about 25 per cent. of oil is obtained from the seeds, and by extraction about 30 to 32 per cent.

Hemp oil has a mild odor, mawkish, unpleasant taste, and a greenish-yellow color, turning brownish-yellow with age. At 59° F. it is 9.6 times more thickly fluid than water. It dissolves in 30 parts of cold and in any quantity of boiling alcohol. It thickens at 3° F. and forms a solid brownish-yellow mass at —16.5° F.

To test the purity of hemp oil, shake it with a mixture of equal parts of nitric and sulphuric acids. The oil becomes first greenish, next brownish, and finally intensely black. The latter color holds for twenty-four hours, after which it changes to red-brown. In the presence of a foreign oil the characteristic black color is not produced.

Generally hemp oil does not dry as well as linseed oil, but it can be very well used for varnishes, especially for those purposes where its dark color will be no hindrance.

Castor oil.—This oil is contained in the seeds of *Ricinus communis*, Linn. The seeds freed from the shell contain from 50 to 60 per cent. of oil, which is obtained by various methods of pressing (partly cold, partly warm, with more or less pressure). The best quality of oil is produced by cold pressure. A commoner kind of oil is prepared by the action of hot steam upon the seeds and subsequent hot pressure, mixing the oil obtained with animal charcoal and filtering through flannel. In the East Indies the method is sometimes adopted of putting the crushed seeds in bags, boiling the latter in water and skimming off the oil floating on the surface.

In the United States a somewhat different method of extraction is used. The cleansed seeds are brought into iron tanks and gently heated with care to avoid roasting, the only object of this operation being to make the oil more fluid. Pressure is then applied and the first quality of oil drawn off. The pressed residue is thrown in a pile, where it remains for one day, when it is again heated and pressed, the product being second quality oil. The third quality of oil is obtained after a repetition of the heating and pressure. Each of these three products is further purified by heating with water to the boiling-point to coagulate the albumen and scum. This is carefully removed and the oil, as soon as cold, is filtered through Canton flannel and put into canisters. Pure castor oil is very viscid, colorless or of a slightly greenish-yellow color, and transparent. It has a mild flavor with a pungent after-taste, the latter being more pronounced in American oil. Its specific gravity at 59° F. is 0.9667. It becomes turbid at 10.5° F., and solidifies at 1.5° to —0.5° F. The American oil, being richer in stearin, solidifies at 14° to 10.5° F.

Castor oil is miscible in all proportions with absolute alcohol and glacial acetic acid. It is soluble at 59° F. in 4 parts of alcohol of 0.835 or 0.850 specific gravity, and mixes without becoming turbid with equal parts of the same solvent at 77° F.

Adulteration of castor oil.—This is generally effected with other fat oils. The elaïdin test, however, does not give entirely accurate results, the behavior of castor oil towards 90 per cent. alcohol being more reliable. For this purpose shake 10 parts by volume of castor oil with 20 parts by volume of 90 per cent. alcohol, and place the flask containing the mixture in a room having a temperature of not more than 86° to 95° F. The presence of another fat oil is immediately recognized by a deposit on the bottom of the flask.

By shaking 10 parts by volume of castor oil with 20 parts by volume of benzine or petroleum-ether and allowing the mixture to stand for three hours at the ordinary temperature of a room, it will be found to have separated into two layers. With pure castor oil the lower layer should amount to at least 14 parts by volume. In the presence of a foreign oil the lower layer is less, it amounting with an adulteration of 10 per cent. of foreign oil to only 10 or 12 parts by volume, with 15 per cent., to 7 or 8 parts by volume, with 20 per cent., to 5 or 6 parts by volume, and with 25 per cent., to 3 or 4 parts by volume. This method of testing is preferable to mixing with alcohol, since it may happen that the oils which have been used for adulteration are also soluble in alcohol.

Exposed to the air in a thin layer castor oil dries *very slowly* and gradually, and hence is of but little value for the manufacture of varnish. But it may be used as an addition to varnishes and lacquers to render them flexible and prevent brittleness, such varnishes, of course, drying somewhat more slowly.

Cotton-seed oil.—This oil is obtained from the seeds of the various species of *Gossypium,* Linn. The seeds after being separated from the lint or wool are pressed into cakes which are subjected to heat and again pressed so as to liberate the oil. The crude oil as obtained from the press is pumped into the oil-room and either barrelled for shipment or refined by treatment with alkaline lye. Four qualities of the oil are known.

Crude oil is thickly-fluid and of a dirty yellow to reddish color; on standing it deposits a slimy sediment. The *second* quality has a pale orange color and is obtained by refining the crude oil. The *third* quality is obtained by further purification of the second; and the *fourth*, which has a pale straw color and a pure nutty taste, by bleaching the third quality.

Crude cotton-seed oil is thickly-fluid, 28 to 30 times less fluid than water, and has a specific gravity of 0.9283 at 68° F., 0.9306 at 59° F., and 0.9343 at 50° F. According to the quality of the oil, palmitin is separated between 54° and 43° F. The oil congeals at 28.5° to 27° F. In taste and odor it resembles linseed oil, and as regards other properties is an intermediate between drying and non-drying oils. By agents yielding oxygen it may, however, be converted into a useful varnish. It is but little used for this purpose, the greater portion of the oil being employed for table use and the adulteration of olive oil.

2. *Resins.*

Numerous plants contain, mostly in special reservoirs, peculiar secretions known under the general term of *resins*. As regards their chemical as well as physical properties, resins differ much from one another. Some possess the consistency of honey, and are called *balsams*; others are hard at the ordinary temperature, but can be readily scratched with a harder substance; whilst others again are so hard as to be capable of scratching other substances.

All balsams possess a peculiar odor, which is, however, gradually lost by long storage. The harder resins are mostly odorless, but develop a slight odor, when rubbed on a rough surface or when gently heated. The balsams when boiled with water yield a volatile oil, and it is in this manner that many of the volatile or essential oils are prepared on a large scale.

As regards the chemical nature of resins, they contain carbon, hydrogen, and oxygen, with occasionally a little sulphur. They are usually of an acid character, and are capable of forming soaps, called resinates, with the alkalies. However, no soap-lather is formed on concentrating the solution of such resin-soaps, and no soap is separated from their aqueous solutions by the addition of common salt. By adding metallic salts dissolved in water to the aqueous solution of resin-soaps, insoluble precipitates are formed, which, when separated and thoroughly dry, are partially soluble in volatile solvents such as ether and alcohol. Solutions of this character are in some cases of value for the manufacture of lacquers.

Different opinions prevail in regard to the origin and formation of resins, but most of them are probably oxidation-products of certain hydrocarbons present in essential oils. For practical purposes it suffices to divide them into three groups, viz.:—

Balsams or soft resins,
Hard resins, and
Gum-resins.

The last-named group comprises a number of substances which differ very much from the actual resins. By simply treating them with water they can be separated into two substances, one of which is of a viscous or gum-like nature and is soluble in water, whilst the other is soluble only in alcohol, and must be designated as the actual resin. Some of these will be discussed later on under "Coloring-matters."

For the manufacture of varnishes and lacquers the following resins are of importance: *Amber, copal, dam-*

mar, *shellac*, *mastic*, *sandarac*, *benzoin*, *elemi*, *pine resin* (*rosin*), *asphaltum*.

Amber.—Amber is the fossil resin of coniferæ of former ages. The chief localities where amber is found are the Prussian shores of the Baltic Sea and the neighboring plains. During storms the amber is thrown upon the beach, but it is also obtained by dredging the bottom of the sea. It is also found in the so-called *blue earth*, and is regularly mined. This blue earth is a peculiar stratum of considerable thickness, which, however, gradually decreases towards the interior of the main land. Amber is also found in the lignite beds of Silesia, and in Alsace, and on the English coast. Some amber, much of a dark color, is found near Catania, Sicily. Near Lemberg, Galicia, nodules of amber occur in rock. It also occurs in several places in Denmark, Sweden, and Norway.

The usual color of amber is yellow, though some pieces are brown, some cloudy and opaque, others transparent. It is frequently found covered with a dull, opaque, brown crust. This crust is especially perceptible in mined pieces, while it is quite thin or entirely wanting in pieces gained from the sea. The natural lustre of amber is fatty. It breaks with a conchoidal fracture, is slightly brittle, and its hardness is 2 to 2.5 on the ordinary mineralogical scale. On being rubbed with a cloth it develops a weak, peculiar odor and becomes electrified.

The size of the pieces of amber found varies, so that a description of its exterior form cannot be well given. The larger pieces are used for making fancy articles, while the small pieces, and all chips that fall off in working amber, form the staple article used by the varnish-maker.

Chemical properties of amber.—Amber is insoluble in water, alcohol, fat and essential oils; it is superficially softened in boiling linseed oil. When treated in a comminuted state with ether, chloroform, benzine, or oil of turpentine, it swells up, but does not dissolve. Amber melts at about 554° F. In fusing it suffers decomposition. It gives off water, succinic acid, marsh gas, and a mixture of liquid hydrocarbons (known as oil of amber), while a more or less dark-colored substance, the so-called *amber-colophony* or fused amber, remains behind. This amber-colophony is the substance which is especially prepared for the manufacture of lacquers by roasting amber. The more care that is exercised in the fusing or roasting of the resin, the more beautiful and the paler the fused amber will be and the more valuable for the preparation of lacquers. By further heating the amber-colophony, a volatile product of a wax-like consistency, the so-called amber-camphor, is obtained. This substance possesses at present only a scientific interest.

The *oil of amber*, which in fusing amber may be obtained as a by-product, forms in a refined state a pale-brown fluid of a strong, disagreeable odor. The crude oil is dark brown, and possesses a very repugnant odor. The specific gravity of the oil is 8.3 at 59° F. By distillation the oil can be separated into two different fluids, one of which becomes volatile only by heating the vessel containing it to a slight red heat, while the other more volatile product shows properties similar to those of oil of turpentine. Oil of amber is an excellent solvent for resins, but its repugnant odor prevents it from being used for that purpose.

Succinic acid, the other by-product obtained in fusing amber, is of no importance for the manufacture of lacquers.

The principal product—amber-colophony—obtained by fusing amber is a resin of a uniform dark-brown color and of considerably less hardness than amber. It readily dissolves in all volatile solvents used in the preparation of varnishes and lacquers. It also dissolves readily in hot fat oils, especially in linseed oil and linseed-oil varnish, whereby only a very small residue should remain.

Adulterations of amber.—The price of amber being comparatively high, it is frequently adulterated in various ways. It is, for instance, imitated by melting pure bleached shellac and keeping it over the fire until it runs clear, care being taken to prevent burning. If necessary, it may be poured into moulds the size of the pieces required. Or shellac is dissolved in an alkaline lye and chlorine passed through the solution until the whole of the lac is precipitated. After washing in water the mass is melted and kept over the fire until it runs clear, when it is poured into moulds the size of the pieces required. Dark and hard pieces of copal are also occasionally substituted for amber. However, these adulterations occur more frequently in the large pieces employed for carvings and fancy articles than in the small chips used in the preparation of lacquers.

To test amber, warm the sample between the fingers: all other resins, even the copals, when thus treated yield a perceptible odor. Heating the sample is another test, whereby additions of inferior qualities of copal may be readily recognized, they fusing at from 356° to 392° F., while amber, as previously mentioned, fuses at 554° F. By holding genuine amber in the flame of a candle it burns without dripping, while copal drips.

Very clumsy sophistications with fused masses of ordinary resins are readily recognized by heating in boiling water.

More difficult is the detection of an admixture of the better varieties of copal. This is best accomplished by the different degrees of hardness of copal and amber. For this purpose split as clear a crystal as possible of rock salt to obtain a clear, lustrous surface, and try to scratch this surface with the sharp edge of the sample. If a streak is produced, even if so minute that it can only be recognized with the microscope, the sample is genuine amber; if no streak is perceptible, the resin is copal. This test, however, applies only to large pieces. Another test is to pound some of the chips in a Wedgewood mortar; the chips of genuine amber will not be readily reduced to powder, the chips flying about, whereas copal grinds up readily and well.

Copal.—The name copal is given to a number of resins which, in many respects, resemble amber, but differ much from one another. Some varieties of copal are mined like amber, but their properties show that they belong to a more recent period, and are, therefore, called *recent fossil resins*. Other varieties are directly obtained from the plants.

Copal is found in commerce in very varying qualities. Usually a distinction is made between the copal from the East and West Indies, though a large number of the varieties are named after the locality from which they have been brought into market. Differing from all other resins in this respect, all varieties of copal are rough and very hard, melt only at a very high temperature, and can only be dissolved with great difficulty in the solvents ordinarily used for resins.

Copal is the most important of all resins used for the fabrication of fat varnishes, and for this reason it is considered necessary to describe more fully the principal varieties. Generally, copal is divided into two classes, namely, hard and soft copal.

Hard copal, East India copal, Zanzibar copal.—This copal is dug out of the ground, and comes from the east coast of Africa. It forms mostly flat, discoid pieces, from the size of a pea up to that of the hand. These pieces are either entirely colorless or yellow to a dark reddish-brown, and are transparent. The surface of this copal is peculiarly crusty, and it is so hard that it can be ground. Zanzibar copal has a specific gravity of 1.068. It resembles amber in so far that it only swells up, without actual solution, in alcohol, ether, and chloroform; it is, however, completely soluble in cajeput oil. When chewed between the teeth it forms a powder that does not cake together.

Copal from Sierra Leone.—This copal has been identified as the resin produced by a tree, *Copaifera Guibourtiana,* which belongs to the sub-order Cæsalpineæ of the order Leguminosæ. Sierra Leone copal occurs mostly in irregular rounded lumps, generally varying in size from that of a hazelnut to that of a walnut. It is equally as hard as the East India copal.

Gaboon copal is roundish, of a yellow color, and many pieces are clouded blood-red.

Angola copal resembles very much the Zanzibar copal, but consists mostly of globular, somewhat flattened pieces, which are almost always of a dark golden-yellow color, but somewhat softer than the other varieties. Both the Gaboon and Angola copal are in all probability produced by different species of *Copaifera.*

Soft copal; West India copal.—By this name certain varieties of copal are known which mostly come into the market from the west coast of Africa, and only in very small quantities from South America. While the plants which secrete the East India copal are comparatively unknown, the South American copal is known to be obtained from different plants belonging to the Hymenæa family. The West India copal generally forms globular or drop-like pieces from the size of a pea to that of a fist, is white, transparent, and sometimes, but rarely, clouded. It is so soft that it will lose substance when rubbed upon woollen stuff. The Madagascar copal is obtained from *Hymenæa verrucosa*, and a Mexican copal is very probably the resin of an allied species.

Kauri, Kawrie, or Cowdi copal.—This copal, which is of comparatively recent introduction, is produced by the Cowdi pine of New Zealand, *Damara australis.* The larger masses, some of them occasionally more than 100 pounds in weight, are found in the earth in many places far from those in which the trees now grow. Kauri resin usually becomes more transparent and yellower by storage. It is generally somewhat whitish, or, when first found, streaked with opaque bands. It is cleaned and scraped and then sorted into several qualities. While all other copals become gritty when chewed, Kauri copal adheres to the teeth. When rubbed between the fingers it develops a not unpleasant odor. Its taste is slightly aromatic. It is partially soluble in alcohol. The use of Kauri copal has greatly extended of recent years. On account of its low price and its easy manipulation, it is now largely employed as the basis of most of the so-called copal varnishes. But the varnish which it yields is inferior in hardness, toughness, and durability to that made from Sierra Leone copal or Zanzibar copal.

Manilla and Borneo copal.—These varieties very much resemble the New Zealand product. Their color is somewhat darker to brown, streaked like agate with lighter bands. The surfaces of the conchoidal fracture can be scratched with a needle without detaching splinters.

Hard copal is tasteless and odorless. The soft varieties have an aromatic smell and taste. Copal is most readily dissolved in chloroform and absolute alcohol, but in the latter only after having first been soaked in water. It dissolves with great difficulty in benzol, oil of turpentine, petroleum-naphtha—all excellent solvents for other resins. It dissolves more readily when it has first been subjected to a partial dry distillation. In fusing it yields volatile products, amongst others oil of copal, which, like the oil of amber, possesses a disagreeable odor, and as, for this reason, it cannot be technically utilized, it may just as well be allowed to escape through the chimney.

As regards solvents, fused copal possesses the same properties as fused amber, and, like it, is chiefly used in the manufacture of lacquers and varnishes.

Dammar.—This resin is obtained from *Damara orientalis*, *Hopea splendida*, and *H. micrantha*. It is gained by incisions which are made in the trunks of the plants, or the spontaneously exuding mass is gathered. It forms drop-like masses as large as a small apple, or sometimes larger stalactic masses. The resin is clear and transparent, with a white dust upon the surface which gives the pieces a dull appearance. The warmth of the hand suffices to render it sticky, and a powder is formed by rubbing it with the finger. The fresh fracture is conchoidal with a glassy lustre. On scratching the fracture with a needle a splintering streak is formed. The commercial article is odorless, but develops a slight odor on heating. At 158° F. dammar becomes perfectly soft, at 212° F. it forms a viscous mass, and becomes fluid at 302° F. It is less resistant towards solvents than copal. It is incompletely soluble in cold alcohol and ether, but dissolves readily in boiling alcohol, as well as in essential and fat oils. It dissolves only partially when heated with potash lye. By adding, however, potash lye to the solution of the resin in oil of turpentine, and boiling until the oil is entirely volatilized, a complete solution is obtained. By adding to this alkaline solution solutions of metallic salts (for instance, acetate of copper) precipitates are formed, which when dried dissolve partially in ether, and in this form may be used in the manufacture of lacquers.

The so-called *artificial dammar—Dutch dammar*—is a product which is obtained by fusing together dammar waste (dammar dust). It is dirty greenish-gray, and quite worthless.

Black or *Kala dammar*, or *Tinnevelly resin*, is produced by *Canarium strictum*, a tree belonging to the Burseraceæ. E. Andres, in "Neueste Erfindungen und Erfahrungen," 1885, p. 519, describes this resin as follows:—

"The resin occurs in broad stalactic masses of a black or brownish color. The form of the masses seems to indicate that the resin has run in a very fluid state over the trunk. With transmitted light the resin is yellowish-brown to reddish-brown, perfectly homogeneous, and has a fracture with a glassy lustre. It is insoluble in cold, and partially soluble in boiling, alcohol. It is readily soluble in oil of turpentine, and in this respect is identical with ordinary dammar. The solution of Kala-dammar in oil of turpentine is yellow in thin layers, but dark in the mass. When subjected to dry distillation the resin yields 78 per cent. of an oil which chiefly resembles ordinary resin oil. In India the resin is used in the preparation of lacquers, for calking vessels, and as an illuminating agent. It is also said to be occasionally used for medicinal purposes.

"On account of its low price it is well adapted for the pale yellow lacquers, the process of manufacture being as follows: Bring the Kala-dammar together with 10 per cent. of the oil of turpentine to be used into a cast-iron kettle of suitable size, place the latter upon the fire, and heat slowly. In consequence of the content of water in the resin the mass soon commences to rise, and to prevent it from running over must from time to time be stirred. The kettle should only be removed from the fire when no more foam is developed and the contents have become clear and boil quietly. The kettle is then removed from the fire, and after allowing to cool for ¼ hour or longer, according to the quantity prepared, add the rest of the oil of turpentine with constant stirring; filter the lacquer thus obtained through coarse linen into storage barrels, and allow it to rest several weeks, when it will be found to be bright and clear. This lacquer dries rapidly, but should be used only for interior decorations."

Andres gives the following special directions:—

I. Kala-dammar, 22 parts; oil of turpentine, 23.

II. Kala-dammar, 24 parts; thick turpentine, 5; oil of turpentine, 27.

III. Kala-dammar, 23 parts; bleached boiled linseed oil, 2; oil of turpentine, 24.

Shellac.—Shellac is a resinous exudation produced by the puncture of a species of coccus (*Coccus Lacca*). The hemipterous insects thus named congregate in large numbers upon the tender branchlets of various East Indian trees, especially *Ficus religiosa*, Linn.; *F. indica*, Linn.; *Rhamnus jujuba*, Linn.; *Croton lacciferum*, Linn., etc. The insects become surrounded with the resinous exudation, which gradually hardens. The impregnated, much enlarged female insects, imbedded in the resin, contain a red coloring-matter in which the young larvæ are developed. These finally eat a passage through the incrusting material and escape. The branches are collected with the incrustation, which is considered more valuable if still containing the red coloring-matter. The thin branches, almost completely covered with numerous small resin nodules, constitute *stick-lac*. The separate nodules or tears are red-brown, and contain in the interior a dark reddish-black powder; after the escape of the young insect the resin is brown. The same resin after having been detached from the twigs constitutes *seed lac* or *grain lac*.

Stick-lac undergoes its first treatment in the place of its production. It is coarsely powdered, brought into large reservoirs, and stirred for several hours in warm water. By this process the coloring-matter separates from the resin and wax. The solution of coloring-matter and the resin-mass are then separately further worked. After the resin-mass has been repeatedly washed in warm water, it is fused and poured out in thin layers upon a smooth surface, when it congeals rapidly. By this process *shellac* is obtained. The various commercial varieties differ only from one another by their color, from darkest red-brown to pale gold-blond, according to the care exercised in removing the coloring-matter. Commercial shellac is called, according to its color, *ruby shellac, blond shellac.*

Another method of working stick shellac consists in passing the twigs through crushing rolls, which are set in motion by a machine. After each passage the product is sifted, what remains upon the sieve being passed through a second and third pair of rolls. The powder is brought together with water into a stirring cylinder and is finely divided by the arms of a shaft, whereby the coloring-matter and the remains of the insects are separated. By the addition of lime the coloring-matter is precipitated from the aqueous solution. The clear water is then drawn off, the precipitate forced through a sieve, again poured off and pressed into cakes, which are allowed to dry in the sun. This constitutes the *lac-dye* of commerce. The purified resin is fused in closed vessels with the assistance of steam heat and drawn off into shallow open troughs, which are also heated. Around the troughs stand hollow columns of sheet zinc inclined towards the interior at an angle of 45°, which are filled with lukewarm water. One workman with a piece of bark now takes up a small portion of shellac and throws it upon one of the zinc columns, when another workman spreads it out and smooths it by means of a pineapple leaf. The layer soon congeals and acquires a fine leathery texture. When hard the layer is removed by a third workman; it is then still hot enough to burn the fingers. The upper portion, which is thicker, is torn off and returned to the melting-kettle. The layers are then hung separately over sticks and carried to the cooling-shed where they are the next day packed in boxes for shipment.

Properties of shellac.—The color varies between dark red-brown and pale brown. In the heat the resin becomes soft and evolves a peculiar, agreeable odor; at an increased heat it melts completely, swelling up very much. It is incompletely soluble in ether, carbon disulphide, and ethereal solutions; but dissolves readily in caustic alkalies and alkaline carbonates, as well as in borax solution; it is separated from these solutions by acids. It does not dissolve completely in cold alcohol, a wax-like body remaining behind. In boiling alcohol it yields a clear solution, which, however, becomes cloudy on cooling in consequence of the separation of this wax-like body. According to Granger, the latter is not a vegetable-wax, but a peculiar fatty acid.

Bleached shellac.—Since the color of commercial shellac prevents its use for many purposes it has to be bleached. The most effective agent for this purpose is chlorine, which, however, strongly attacks and changes the resin substance, and by careless manipulation the shellac may be rendered entirely useless.

Wittstein recommends the following method for bleaching shellac: Make a solution of 1 part by weight of chloride of lime in 4 parts of water, and mix it with a solution of 1 part of potash in 3 parts of water until no more precipitate is formed. Then allow to settle and filter the clear fluid. To the clear bleaching fluid add gradually a solution of 1 part blond shellac in 4 parts 90 per cent. alcohol, and after shaking allow the mixture to stand for some time. In the course of half an hour the resin may be precipitated by the addition of hydrochloric acid in excess, which is best effected by first diluting the hydrochloric acid with the necessary quantity of water (1 : 5) and pouring the shellac solution in a thin stream into the dilute acid. The separated resin is immediately washed with water. It is then kneaded in boiling water until the water runs off colorless. The resin while still warm is rolled into sticks.

To prevent as much as possible the injurious effect of chlorine upon shellac, Sauerwein recommends an addition of sodium sulphide to the resin precipitated by hydrochloric acid.

Shellac which in bleaching has been too strongly attacked by chlorine is soluble with great difficulty in alcohol. This may, however, be overcome by pouring ether over the comminuted shellac and allowing it to stand 24 hours. The shellac swells up in the ether and dissolves more readily in alcohol.

The above-described behavior of shellac bleached with chlorine is very annoying, and has the further disadvantage that such shellac cannot be used for lacquers for metals. As the chlorine cannot be completely removed from the shellac by washing, it becomes effective later on when the resin is applied in the form of lacquer, disagreeable features being produced especially upon metallic surfaces.

Another method of bleaching shellac which does not alter the resin is the treatment with animal charcoal, as originally given by Elsner. The alcoholic solution of the shellac is agitated with coarsely powdered animal charcoal. It is recommended to extract previously the animal charcoal with hydrochloric acid, then to remove the acid by washing, and finally to dry. The quantity of animal charcoal added to the shellac solution should be such that a thin paste is formed. The mixture is for several days exposed to the sunlight, care being taken, however, to avoid heat. When a filtered sample appears to be sufficiently bleached the paste is brought upon a filter and allowed to drain off. The animal charcoal remaining upon the filter may be rinsed with a little alcohol. By this process a very good product is obtained, but at a considerable loss of resin, a portion of which is tenaciously retained by the animal charcoal. This method of bleaching being too expensive is but little used.

A useful, though still perceptibly colored, product is obtained by the following process: The shellac is gradually brought in small portions into a boiling soda solution, care being taken not to introduce a fresh portion before the preceding one is dissolved. Sufficient shellac is added so that the soda is present only in slight excess. When all is dissolved keep the whole boiling for some time, with constant stirring. Then carefully cover the kettle and allow to cool. After cooling, the wax is found separated on the surface. It is taken off, if necessary filtered, and the clear shellac solution decomposed by hydrochloric acid. The separated shellac is repeatedly washed with warm water.

Adulteration of shellac.—Shellac is sometimes adulterated with colophony. The detection of the latter is difficult, since we have to deal with two resin bodies which exhibit a similar behavior towards solvents, with the exception of petroleum-ether, which dissolves of pure shellac only 1 to 2 per cent., but of stick lac or of grain lac 3 to 15 per cent. Ether may also serve for testing, it dissolving at the utmost 5 per cent. of shellac, but colophony completely. To make either one of these tests, shake the previously pulverized sample of shellac with one of the above-mentioned solvents, filter off the undissolved portion, and allow the solution to evaporate. The residue gives approximately the quantity of colophony added after deducting the shellac taken up by the solvent. This method is, however, uncertain, the results not being sufficiently satisfactory.

A more rational method is recommended by Wiesner. It is based upon the different densities of the two resins. Prepare a solution of common salt or cane-sugar in water which shows a specific gravity of exactly 1.08, or at the utmost of 1.09 at 59° F. Colophony floats on the surface of such a solution, while shellac sinks to the bottom. Mix the powdered and uniformly sifted resin with the solution and shake vigorously. The principal mass of the powder collects first on the surface, but the heavier shellac powder soon begins to sink, quite a sharp separation of the two resins taking place. The upper lighter layer is then carefully poured off and filtered. After washing with water and drying, and, if desired, careful fusing, it is weighed, the exact quantity of colophony added being thus ascertained.

Mastic.—The best and most important sort of mastic is produced by a small tree, *Pistacia Lentiscus*, Linn., belonging to the cashew-nut order, or Anacardiaceæ. This tree occurs in Scio and other islands of the Greek Archipelago. To obtain the resin, vertical incisions are made in June and July in the bark of the trunk and larger branches, and in July and August, after the exuding mass has hardened, it is carefully removed from the trees and collected in baskets. This is the finest quality. An inferior quality consists of the tears which have dropped from the incisions upon the tiles or flat stones kept under the trees.

The best quality of mastic is in globular or more or less elongated brittle tears of the size of a pea, which are externally coated with a whitish dust, or have been freed from it by washing, and are then of a pale-yellow color, perfectly transparent, of a glass-like lustre, and break readily with a conchoidal fracture. Placed between the teeth the resin is easily crushed, and then softens into a plastic mass. Its specific gravity is 1.04 to 1.07. It has a balsamic odor, more apparent on being heated, and a not unpleasant taste. At the ordinary temperature mastic is very brittle; it softens at 210° F., and fuses at 217° F., but after long storing only at 248° F. Towards solvents it is somewhat indifferent, it dissolving incompletely in the ordinary solvents for resins. Alcohol dissolves about $\frac{9}{10}$, and cabon disulphide about $\frac{3}{4}$ of the resin, while hot acetone dissolves it completely.

The inferior kind of mastic consists of similar tears, to which sand and fragments of bark adhere mixed with gray or brown-colored pieces.

Bombay mastic.—Under this name a resin has appeared in the market which, when well selected and clean, closely resembles the Scio mastic but is usually in less clean and opaque tears. It is obtained from *Pistacia cabulica* and *Khinjuk*, Stocks, which are indigenous to Northwestern India and Beloochistan.

Mastic is seldom adulterated with other resins, though some varieties of gum-products resembling gum tragacanth from *Antractylis gummifera* and *Echinops viscosus*, are said to be used for the purpose. Such adulteration may, however, be readily detected by treating the mastic in question with water, by which the gum-like substances are extracted and separated in the form of a jelly.

Sandarac.—This resin exudes from the bark of a species of cypress, *Callitris quadrivalvis*, Ventenat, a small tree of Northeastern Africa. It forms brittle, elongated tears of a pale, yellowish color, with a dusty surface, a glass-like fracture and transparent. Its specific gravity is 1.066. The resin softens at 212° F. and fuses at 275° F., whereupon it swells up and evolves a peculiar odor. When masticated it becomes pulverulent. It dissolves completely in hot absolute alcohol (wherein it differs from mastic), and in ether, amyl alcohol, and acetone. It is not completely dissolved by chloroform and carbon disulphide, and only in small proportion by benzol and petroleum-ether.

The best means of distinguishing mastic and sandarac, which externally often resemble one another, is their behavior when chewed between the teeth. Mastic softens into a plastic mass, while sandarac becomes pulverulent.

The Australian sandarac recently brought into the market possesses nearly the same general and chemical properties as the African product, it differing from the latter in the size of the tears, which are not perfectly clear and frequently very cloudy.

Sandarac is seldom adulterated, but it is well to be on guard against the so-called German sandarac, which consists of the resin exuding from old juniper bushes, especially near the roots. It is readily distinguished from genuine sandarac by its characteristic odor when heated.

Benzoin.—For the manufacture of lacquers, this resin is only of secondary importance, it being chiefly used on account of its agreeable odor as an addition to lacquers which, when applied to articles, must stand a high temperature. The resin is obtained from *Styrax Benzoin,* a tree of medium height, indigenous to Borneo, Java, and Sumatra. In Sumatra it is cultivated to a considerable extent, but benzoin is also obtained from wild trees.

When the tree is about six or seven years old, incisions are made through the bark, when a white liquid resin commences slowly to exude. When sufficiently hard this is scraped from the bark. During the first three years the resin contains a large number of white tears, and is then called by the Malays *head benzoin.*

During the next seven or eight years the tears decrease in number, and the product is termed *belly benzoin.* At the expiration of this time the exudation is considerably diminished, the tree cut down, and an inferior quality, called *foot benzoin*, scraped from the wood.

Benzoin in tears.—This variety is met with in separate or loosely agglutinated, roundish or flattened pieces, one or sometimes two inches in diameter, which are of a reddish-yellow color externally, internally white or striped, and melt at 167° F.

Amygdaloid benzoin.—The better quality is distinctly amygdaloid in appearance on account of the milk-white tears, which are up to one-half inch in diameter, and imbedded in a red-brown translucent resin.

Ordinary benzoin contains the above-described varieties in a porous brown resin-mass. It is brought into commerce in large rectangular blocks, which externally show the mode of packing and the impress of the material used for wrapping.

All the above-mentioned varieties of benzoin possess a peculiar odor, which becomes more apparent on heating. Their taste is somewhat sweetish and acrid. The odor of some varieties, especially of Siam benzoin, is pleasantly balsamic, somewhat like that of vanilla. With the exception of mechanical admixtures, benzoin should completely dissolve in alcohol. It is, however, only partially soluble in ether and in essential and fat oils. When strongly heated it diffuses an agreeable odor with the evolution of white vapors of benzoic acid, and possibly also of cinnamic acid. By distilling benzoin with water, a very small quantity of essential oil, possessing an agreeable odor, is obtained.

For testing benzoin dissolve it in pure concentrated sulphuric acid. All commercial varieties dissolve in the acid with a beautiful purple color.

Elemi.—The botanical source of this resin is undetermined, but is probably *Canarium commune*, Linn. The elemi now found in the market is chiefly imported from Manilla. Other countries, especially Brazil and the West Indies, also produce elemi resins, which, however, differ essentially from the Manilla elemi, which is chiefly employed. All these substances are balsamic resins of the consistency of ointment, which become hard by long storage, but can even then be readily softened. Manilla elemi is distinguished from all others by its perfect crystalline structure, this feature being less prominent in all other varieties.

Elemi forms soft, viscous masses, closely studded with small crystals, and of a greenish-white color. Its odor resembles that of dill and fennel, but when the resin is older and harder it has a somewhat terebinthinate odor, and its color is more lemon-yellow. The hardened resin breaks with the slightest pressure and softens very readily. Elemi belongs to the soft resins, it being softer than colophony, and shows upon the freshly-fractured surface a fatty lustre. Its specific gravity varies between 1.018 and 1.083. Its behavior on heating is peculiar; it softens at 176° F., becomes partially fluid at 212° F., but fuses completely only at 393° F. Fresh elemi is a mixture of an essential oil (generally 10 per cent.), an amorphous resin, and a crystallizable resin, the latter constituent being of great value in establishing the identity of the resin.

If a drop of elemi is placed upon a slide, and after spreading out by gentle heating is allowed to cool, it exhibits but few characteristics when viewed with the microscope. But on moistening the drop with a drop of alcohol, the entire mass in a short time appears as a well-characterized conglomerate of crystals, the separate constituents of which have a long rod-like form.

Even the better qualities of elemi are mixed with chips and other impurities, which is due to the crude methods of gaining it. It can be freed from the greater portion of these impurities by careful melting and straining through coarse linen.

Adulteration of elemi.—Elemi is almost exclusively adulterated with turpentine, which is of about the same consistency. Such sophistication can be readily detected with the microscope. The crystalline constituents of turpentine have a bone-like form, and hence are readily distinguished from the straight-lined rods of elemi.

In the manufacture of lacquers and varnishes, elemi is employed to give greater elasticity to these products.

Pine resin (*common resin, rosin*).—From the trunks and branches, as well as from the roots, of *Pinus palustris* and other species of *Pinus*, exudes a resin which, in a fresh state, is quite fluid, but soon hardens to a viscous balsam of a peculiar nature. This balsam is yellow-brownish, unctuous, and viscous, but also exhibits a granular appearance. It has a strong odor of oil of turpentine, and serves as the initial material for the fabrication of a number of products. The balsam is known as *thick or common turpentine.*

By distilling this turpentine with water, *oil of turpentine,* together with condensed aqueous vapors, is obtained as the product of distillation. An opaque, yellow-brown, resinous body remains behind, which is brought into commerce under the name of *boiled turpentine.* It is found in the market in cylindrical pieces, which are very porous, and never clear and transparent. The quite smooth fracture shows a fatty lustre. Boiled turpentine contains much water. By careful heating, until the content of water is entirely removed, boiled turpentine yields a clear, nearly transparent resin, which, according to the temperature employed in expelling the water, is of a more or less dark color. This resin is the *common resin, rosin or colophony.* If ordinary turpentine is heated by itself, without water, until freed from oil of turpentine, a yellow resin remains behind which is opaque and only slightly translucent on the edges. This is common rosin.

While the above-mentioned substances do not exhaust the products which may be prepared from common resin, they are the chief representatives of such products.

Ordinary turpentine is a thick, viscous balsam, which, according to its derivation and the care with which it has been treated, has a more or less agreeable odor. It consists of a resin and a volatile oil—oil of turpentine, the quantity of the latter varying between 15 and 30 per cent. The less oil of turpentine the balsam contains the more solid and granular its exterior condition is, and the more oil is present the more thinly-fluid the balsam is. Common turpentine has an intensely bitter taste; by treatment with water the bitter substance is removed. Common turpentine is not adulterated; it serves, however, as an adulterant, it being the cheapest of all resins.

Venice turpentine is procured from the branches of *Larix dacidus,* the European larch. It differs essentially from ordinary turpentine. It comes into commerce as a clear, transparent, yellow balsam of a peculiar odor. At the ordinary temperature it is very viscid, but by gentle heating it becomes more thinly-fluid, so that it can be conveniently poured from one vessel into another. It has a terebinthinate odor, which, however, also reminds one of oil of lemon. Its taste is bitter and aromatic. It contains 15 to 25 per cent. essential oil. The resinous body contained in Venice turpentine is not crystalline. If once clarified by separating the water contained in it, Venice turpentine remains clear even when exposed to quite a low temperature.

Venice turpentine is frequently adulterated with common turpentine, such sophistication being, however, difficult to detect. The presence of common turpentine may be approximately established by carefully expelling the essential oil and adding a drop of acohol to the solid resinous residue. If the latter thereby becomes crystalline, common turpentine is present. Ordinary turpentine made clear by diluting with oil of turpentine is also occasionally sold as Venice turpentine. Such article may be recognized by the odor, and also by the above-described test.

The properties of oil of turpentine will be discussed later on, under "Solvents."

Boiled turpentine is the resin remaining behind in distilling oil of turpentine, and is brought into commerce in cylindrical pieces. It always contains quite a considerable quantity of water, which gradually evaporates from the surface. According to the degree to which this evaporation progresses, the resin becomes more transparent and clearer, and hence the fracture of a cylindrical piece is in the centre yellow with a reddish, translucent edge. The oil of turpentine cannot be entirely removed from the resin, the latter always having a perceptible odor of turpentine.

Common rosin contains a somewhat larger quantity of oil of turpentine than boiled turpentine, and is opaque by reason of containing a considerable quantity of water. It is completely soluble in strong alcohol. On heating it fuses with a crackling noise, caused by the escaping water. To determine the content of water of the two above-mentioned varieties of resin, place the very finely pulverized resin in a closed vessel over concentrated sulphuric acid until the weight no longer decreases.

Colophony is the resin freed from the entire content of water by carefully heating common rosin or boiled turpentine. For the production of quite pale colophony, heating must not be carried too far. Colophony is brought into commerce in almost pale yellow to dark brown pieces. It is hard at the ordinary temperature, softens at 176° F., and melts between 194° F. and 212° F. It dissolves readily and completely in eight times the quantity of strong alcohol; it is also soluble in benzol, acetone, carbon disulphide, ether, and chloroform, the solutions showing slight fluorescence. This resin also is never entirely free from oil of turpentine, the better qualities containing 1 or 2 per cent. of it.

Asphaltum belongs to the fossil resins, it being probably the resin of petroleum. It is found in many places throughout the world, stored in the earth or floating upon the sea, the best known localities being the Dead Sea, the Pitch-Lake in the Island of Trinidad, in England, France, Southern Tyrol, etc. In the first three named localities it is found in large masses floating upon the water; in the others it is regularly mined. The so-called asphalt rock is a strongly bituminous limestone, from which large quantities of asphaltum are obtained.

Asphaltum is a pitch-black, brittle mass, with a flat, conchoidal fracture. Its specific gravity varies between 1.07 and 1.17. It is tasteless, contains but little essential oil, and generally diffuses a disagreeable odor, resembling that of burning coal, which is especially perceptible when it is heated. It melts at 212° F. Absolute alcohol dissolves only about 5 per cent. of it, ether about 70 per cent., oil of turpentine and fat oils about 50 per cent., essential oils about 33 per cent., the solutions showing a brown or black color. When set on fire it burns with a bright flame, depositing large quantities of soot, but leaving behind little ash, and this is made use of as a means of testing its purity, as adulterated asphaltum, which has been mixed with a bad quality of pitch, leaves a large quantity of ashes behind. Asphltum is much used for making excellent elastic black lacquers, especially suitable for lacquering ironware.

Besides the native variety there is an artificial asphaltum—a chemical product—obtained in the distillation of tar oils. The use of this variety is more advantageous for the fabrication of lacquers. It resembles the natural products, but softens more readily and is less indifferent towards solvents.

The following table shows the solubility, specific gravity, and melting-points of the resins chiefly employed in the fabrication of lacquers and varnishes:—

Table showing the Solubility. Specific Gravity, and Melting-points of Resins.

Name.	Specific gravity at 59° F.	Melting-point, degrees F.	BEHAVIOR TOWARDS					
			Alcohol.	Ether.	Chloroform.	Amyl alcohol.	Carbon disulphide.	Benzine.
Amber	1.005 to 1.007	—	Slightly soluble.	Slightly soluble.	Slightly soluble.	Slightly soluble.	Insoluble.	Insoluble.
Amber, fused .	—	536	Readily soluble.	Readily soluble.	Soluble.	Soluble.	—	—
Asphaltum . .	1.07 to 1 17	—	Very little soluble.	About 50 per cent.	Completely soluble.	Soluble.	Readily soluble.	Completely soluble.
Benzoin . . .	1.003	—	Readily soluble.	Readily soluble.	Partially soluble	Partially soluble.	—	Partially soluble.
Colophony . .	1.070	221	Soluble.	Soluble.	Soluble.	Soluble.	—	Soluble.
Copals	The behavior of the various kinds of copals towards solvents varies very much, as previously described.							
Copals, fused . .	Fused copals dissolve with comparative facility.							
Dammar . . .	1 056	167 to 212	Partially soluble	Completely soluble.	Completely soluble.	Partially soluble.	Soluble.	Soluble.
Dragon's blood .	1.196	—	Readily soluble.	Partially soluble.	Completely soluble.	Readily soluble.	—	Soluble.
Elemi	1.018 to 1 083	248	Completely soluble.	Completely soluble.	Completely soluble.	Completely soluble.	Badly soluble.	Partially soluble.
Gamboge . . .	—	212	Readily soluble.	Readily soluble.	—	—	Soluble.	—
Mastic	1.079	212 to 236	Completely soluble.	Completely soluble.	Completely soluble.	Completely soluble.	Soluble with difficulty.	Soluble.
Sandarac . . .	1.066	302	Completely soluble	Completely soluble.	Partially soluble.	—	Slightly soluble.	Partially soluble.
Shellac	1.139	—	Soluble.	Partially soluble.	Partially soluble.	Completely soluble.	Insoluble.	Insoluble.
Turpentine .	Variable.	Fluid.	Completely soluble.	Completely soluble	Completely soluble.	Soluble.	Partially soluble.	Partially soluble.

Table showing the Solubility, Specific Gravity, and Melting-points of Resins.—Continued.

Name.	Specific gravity at 59° F.	Melting-point. degrees F.	BEHAVIOR TOWARDS					
			Petroleum-ether.	Acetone.	Oil of turpentine.	Fat oils.	Soda solution.	Caustic alkalies.
Amber	1.005 to 1.007	—	Insoluble.	Slightly soluble.	Slightly soluble.	Insoluble.	—	—
Amber, fused .	—	536	—	Soluble.	Completely soluble.	Soluble	—	—
Asphaltum . .	1.07 to 1.17	—	Incompletely soluble.	Soluble.	Slowly soluble.	—	—	Partially soluble.
Benzoin . . .	1.003	—	Partially soluble.	—	—	Insoluble.	Partially soluble	Partially soluble.
Colophony . .	1.070	221	Partially soluble.	Soluble.	Soluble.	Soluble.	Soluble.	Soluble.
Copals	The behavior of the various kinds of copals towards solvents varies very much, as previously described.							
Copals, fused . .	Fused copals dissolve with comparative facility.							
Dammar . . .	1.056	167 to 212	Soluble.	—	Soluble.	Completely soluble	—	—
Dragon's blood .	1.196	—	—	—	Soluble.	Partially soluble	Partially soluble.	Soluble.
Elemi	1.018 to 1.083	248	Soluble with difficulty.	Partially soluble.	Completely soluble.	Partially soluble.	—	Nearly insoluble.
Gamboge . . .	—	212	—	—	—	—	—	Soluble.
Mastic	1.079	212 to 236	Soluble.	Soluble.	Soluble.	Almost insoluble.	Insoluble.	Insoluble.
Sandarac . . .	1.066	302	Soluble with difficulty.	—	Soluble.	—	—	Almost insoluble.
Shellac	1.139	—	Insoluble.	Readily soluble.	Insoluble.	Slightly soluble.	Partially soluble	Partially soluble.
Turpentine . .	Variable.	Fluid.	Partially soluble.	Soluble.	Completely soluble.	—	Emulsion.	Partially soluble.

Resinate esters (*Harzsäureester*).—Under this name, C. Schaal, of Stuttgart, Germany, brings into commerce resin-like products, prepared according to a patented process, which are highly recommended for the preparation of varnish. The process of preparing them is briefly as follows :—

Crude resinates are first freed by distillation or extraction from the more volatile or softer portions, and the hard residues of resinates are condensed to esters with alcohols or phenols by heating with or without pressure, and with or without the addition of substances promoting reaction. The resinate esters are separated by distillation in vacuum into softer and harder resin-like bodies. For the preparation of lacquers and varnishes from resinate esters, the latter are treated in the same manner as the natural resins with volatile and fat oils, hydrocarbons or spirits of wine.

According to an additional patent, the separation of the softer and more volatile portions is effected only after the conversion into esters. Therefore, the original resinates are condensed to esters with alcohols or phenols by heating with or without pressure, and with or without the addition of substances promoting reaction, and the resulting mixture is separated by distillation into softer or harder esters and oily portions.

3. *Caoutchouc and Gutta-percha.*

Caoutchouc exists in the milky juice of a very large number of plants in the form of minute or larger granules, frequently associated with starch-granules, and kept in suspension by mucilage. Plants capable of yielding caoutchouc are found in all parts of the world, and belong mostly to the natural orders of Urticaceæ, Euphorbiaceæ, Apocynaceæ, and Asclepiadaceæ, but only species growing in the tropics yield the product in large quantity. The manner of obtaining caoutchouc and the first treatment of the product vary so much in the different countries that the qualities of the separate commercial varieties vary considerably. The following are the principal commercial varieties of caoutchouc:—

Para caoutchouc is the best variety. It is derived from Brazil, and comes into market either in the form of spherical bottles, round disks, or square plates, the last two varieties being probably obtained by drying the crude juice upon a flat support, or by cutting open the bottles. The outer layers of the bottles, as well as of the disks, are generally black-brown, while the interior is of a light color and frequently entirely white.

Carthagena caoutchouc comes into the market in lumps almost of a black color and frequently weighing as much as 110 lbs. It is obtained in New Granada and is very highly valued.

African caoutchouc is least valued. It is frequently smeary, and separates a dark, slightly sticky fluid. The exterior condition of caoutchouc is dependent, as previously mentioned, on the treatment of the crude, milky juice. In thin layers caoutchouc is translucent, and shows under the microscope numerous pores which traverse the interior. The most prominent quality of caoutchouc is its elasticity, which, however, considerably decreases at an increasing temperature. If caoutchouc in a stretched state is exposed to a very low temperature, it remains so for a long time, but on moderately heating it again becomes elastic. Chemical agents scarcely attack it. Concentrated sulphuric acid when allowed to act for a long time produces slight carbonization. Concentrated nitric acid attacks caoutchouc and decomposes it after some time. Caustic alkalies do not perceptibly affect it either in the cold or on heating. By the action of ammonia a peculiar emulsive mass is formed, but by evaporating the ammonia with the assistance of heat, pure caoutchouc remains behind. On heating to 248° F. caoutchouc becomes fluid and remains somewhat sticky after cooling. If subjected to dry distillation, it yields, besides gaseous products, *oil of caoutchouc*, which is an excellent solvent for caoutchouc.

Towards solvents caoutchouc exhibits a very peculiar behavior. Most of the solvents penetrate it more or less completely and cause a swelling up of the mass. In many cases a portion of the caoutchouc is thereby dissolved, but is tenaciously retained by the swelled, undissolved portion. Hence, for complete solution a large quantity of solvent is required. If solution is effected with the assistance of heat, the caoutchouc is frequently decomposed. On evaporating such a solution a mass remains behind which no longer possesses in every respect the properties of caoutchouc, it being especially distinguished by a decreased capacity of drying. By the use of mixtures of different solvents, solutions are, however, obtained which contain the caoutchouc in an unchanged state and leave it on drying in a thin layer.

In dissolving caoutchouc particular attention must be paid to its content of water; *that containing water never dissolving completely*. Hence it must previously be carefully dried, which is best effected by exposing it in a comminuted state to a temperature of from 158° to 176° F. until the weight no longer decreases.

In *water* caoutchouc is insoluble; *absolute alcohol* penetrates it without dissolving it, while *ether* dissolves 1 per cent. of it, whereby the non-dissolved portion swells up very much. It is not dissolved by *drying oils*. *Non-drying oils* dissolve considerable quantities of it with the assistance of heat, the qualities of the caoutchouc, however, thereby suffering injury. *Petroleum, oils of rosemary and lavender* dissolve a small quantity; after evaporation there remains behind a smeary residue, which finally becomes dry and brittle.

Oil of caoutchouc is an excellent solvent, the caoutchouc retaining all its excellent qualities. *Oil of turpentine*, which contains 3 to 5 per cent. of sulphur, is also a good solvent, as well as *chloroform, benzol*, and *carbon disulphide*.

A mixture of 100 parts of *carbon disulphide* and 6 to 8 parts *absolute alcohol* gives a solvent which, after evaporation, leaves the caoutchouc in an unchanged state.

Sand, particles of bark, leaves, etc., are found as impurities of caoutchouc, these substances being mixed with it in the first treatment of the raw material. A too large content of water, which may also be considered a mechanical admixture, must, however, be especially guarded against.

Gutta-percha is also the concrete exudation of a plant, *Inosandra gutta*, which belongs to the family of the Sapotaceæ. It is a stately tree, 40 to 60 feet high, with few branches, with evergreen oblong or obovate, entire, glossy, and underneath brownish-yellow, scaly leaves, and small, white flowers aggregated in little clusters near the top of the branches. It is common in the jungles of the Malay peninsula and of the Malayan Archipelago.

Gutta-percha is grayish or yellow, frequently with red-brown streaks from fragments of bark and other impurities. It is hard and rather leathery or horny, in thin pieces somewhat flexible, and is readily cut with a knife. In water of about 158° F. it becomes soft and plastic. At 212° F. it becomes thickly-fluid and at 248° F. thinly-fluid. When subjected to dry distillation it yields a volatile oil, which may be used as a solvent for gutta-percha. By exposing gutta-percha in the air to the action of light and moisture, it becomes friable and brittle, and is converted into a resin-like substance.

Gutta-percha is purified either with carbon disulphide or chloroform. The mass, previously softened in warm water, is pulled to pieces with the fingers, and after superficial drying dissolved in one of the above-mentioned solvents. The solution is then mixed with strong alcohol, which absorbs the resinous constituents of the raw material and separates the pure gutta-percha solution. After separating the two layers of fluid and evaporating the solution, the gutta-percha remains behind in a nearly white state.

Towards chemical agents gutta-percha is quite indifferent. Caustic alkalies produce no effect, nor do dilute acids or salt solutions. In concentrated sulphuric acid it swells up, and on heating gradually carbonizes. It is readily attacked by concentrated nitric acid, various products of oxidation being thereby formed.

Gutta-percha is almost entirely dissolved in chloroform and carbon disulphide, and, with the assistance of heat, also in benzine, oil of turpentine, petroleum, and coal-tar oil; absolute alcohol dissolves but little of it with the assistance of heat, while ether dissolves somewhat more. It is readily soluble in oil of caoutchouc and its own pyrogenous oil.

As regards the impurities of gutta-percha, what has been said about caoutchouc applies to it.

4. *Solvents.*

Of the solvents important for the manufacture of lacquers and varnishes, the fat oils have already been discussed, and the behavior of resins towards solvents has also been given. Hence, it remains only to mention the other solvents which, besides fat oils, are employed. All these solvents belong to the volatile bodies, the following being used: *Wood-spirit, spirit of wine, ether, acetone, benzol, chloroform, carbon disulphide, light coal oil, oil of turpentine.*

It must be remembered that all these fluids are inflammable, and when mixed in a vaporous state with air they form readily explosive mixtures. Hence, in using them great care has to be exercised.

Wood-spirit or methyl alcohol is a product of the destructive distillation of wood, forming about 1 per cent. of the aqueous distillate.

Crude wood-spirit contains, besides a number of other well-characterized organic combinations, a considerable quantity of a tar-like body, which imparts to it a deep brown color and a disagreeable empyreumatic odor. It is difficult to free entirely the wood-spirit from these tar-like admixtures, and for this reason the purified product is comparatively expensive.

Pure wood-spirit is a colorless mobile liquid, possessing a pure spirituous smell, and resembles ordinary spirits of wine—ethyl alcohol. Its specific gravity at 59° F. is 0.7894, and it boils at 151° F. It is miscible in every proportion with water. Wood-spirit entirely free from water is seldom demanded in commerce, the absolutely pure product containing mostly 99 per cent. of methyl alcohol; this corresponds to a specific gravity of 0.800 at 59° F.

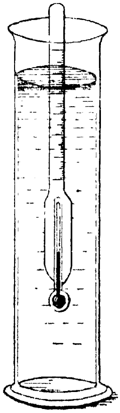
For the manufacture of lacquers, perfectly pure wood-spirit is not required; it must, however, be free from the tar-like admixtures. A small content of acetone and of bodies of a similar composition rather increases the solvent power.

Tar-like admixtures are readily recognized by the characteristic odor. Acetone and bodies similar to it are detected by the odors peculiar to these fluids, left behind after evaporating the wood-spirit. For the purpose of testing, moisten a linen rag with the wood-spirit, allow it to evaporate at the ordinary temperature of a room, and test with the nose.

Spirits of wine or ethyl alcohol is obtained by the vinous fermentation of sugar, and is found in a diluted state in all spirituous liquors, such as beer, wine, or whiskey. Perfectly pure ethyl alcohol is a colorless, mobile fluid, almost odorless; it boils at about 174° F., and when it is cooled down to —148° F. it becomes viscid, but does not solidify. It should be perfectly volatile and not change sensitive litmus paper. By storing in new barrels it frequently acquires a yellowish to yellow-brownish color. That this coloration is only due to the extractive substances of the wood is readily recognized by the alcohol becoming darker on the addition of a few drops of lye. By allowing the alcohol to evaporate upon the hand no odor of fusil oil should be detected. This test may also be made by moistening a clean linen rag. Or add to 25 to 30 cubic centimeters of the alcohol to be tested 8 to 10 drops of potash lye, and allow the mixture to evaporate in a small dish until only a small residue remains. By the same test *beet-root alcohol* is recognized by its peculiar odor, or by the rose-color coloration produced on mixing it with ½ part by volume of pure concentrated sulphuric acid.

Spirits of wine is the stronger alcohol that is generally found in commerce, and contains about 90 per cent. of alcohol and 10 per cent. of water.

Fig. 9.



Rectified spirits are spirits rendered stronger and purer by redistillation.

Cologne spirit is the highest grade of alcohol, having been so purified as to be devoid of all color and odor.

In commerce it is customary to designate the quantity of pure alcohol contained in a fluid by per cent. or degrees. The percentage is generally guaranteed by the manufacturer, but can be readily ascertained by means of an instrument called an alcoholometer or hydrometer. Fig. 9 shows the Tralles alcoholometer. The number on the scale to which the instrument sinks into the fluid indicates at once how many per cent. of pure alcohol it contains.

Ether, ethyl oxide, diethyl ether, sometimes wrongfully, in commerce, called sulphuric ether, is obtained by heating a mixture of strong alcohol and concentrated sulphuric acid to 284° F.

Pure ether is a very mobile liquid, possessing a characteristic penetrating odor and burning taste. It boils at 94° F., and at 59° F. has a specific gravity of 0.728. It is somewhat soluble in water, 12 parts of the latter at a medium temperature dissolving about 1 part of it. It mixes with alcohol in all proportions. It is highly inflammable, burning with a luminous flame. Its vapor, which is 2.557 times heavier than water, and which can be poured from vessel to vessel, forms with air an explosive mixture.

Ether should not change sensitive litmus paper, and should evaporate without residue at the ordinary temperature of a room. The solution of pure ether in water is clear; if it opalizes, it may be due to a content of heavy oil of wine. On evaporating such ether upon linen or three or four thicknesses of blotting-paper, an odor remains for some time. A content of water in ether is established by shaking it with dust-dry carbonate of potash. In the presence of any considerable quantity of water the carbonate of potash becomes moist and adheres to the sides of the vessel. Pulverized tannin is still more suitable for this purpose, it running together on the bottom of the vessel to a syrupy fluid. For the detection of alcohol, shake equal parts by volume of the ether to be tested and of water in a graduated cylinder, and allow the mixture to repose. The fluid then separates into two layers, of which the lower aqueous one will be the greater the more alcohol is contained in the ether. The above-mentioned tests suffice for all practical purposes.

Acetone is found in the aqueous products of the destructive distillation of wood. It is obtained in a pure state by the distillation of a mixture of calcium acetate and quicklime. It forms a clear, colorless, mobile fluid, boiling at 133° F., and having a pleasant odor. The specific gravity of the commercial article varies between 0.792 and 0.800 at 15° F. It is inflammable and burns with a bright flame. It is miscible in every proportion with water, spirits of wine, ether, and chloroform. It is an excellent solvent for fats, resins, etc., but its general use is prevented by its rather high price.

To detect the presence of water in acetone shake the sample with dry calcium chloride, which, if the acetone be free from water, should not deliquesce. A slight opalescence of a mixture of water and acetone indicates a content of empyreumatic substances.

Benzol.—Pure benzol by itself is not used in the manufacture of lacquers, but it has been so often mentioned in describing the properties of and tests for resins, that for the purpose of testing these substances it seems advisable to give a short description of its properties.

Benzol is obtained from the light coal-tar oils. In a pure state it is colorless, of considerable refractive power, mobile, of a peculiar, not disagreeable odor, boils at 176° to 212° F. and burns with a bright flame, depositing much soot. Its specific gravity at 59° F. is 0.8841. It is only slightly soluble in water, but the water shaken with it possesses the peculiar, sweetish, benzol odor. At 23° F. benzol congeals to a crystalline mass, and can in this manner be readily freed from adhering foreign hydrocarbons. It is an excellent solvent for fats, oils, resins, and caoutchouc, but on account of its high price cannot be advantageously used in the manufacture of lacquers.

Chloroform.—For the preparation of lacquers the ordinary commercial article may be employed. It is a clear, mobile, colorless fluid, which does not change litmus paper. It has a peculiar, sweetish, ether-like odor and taste. Its specific gravity varies between 1.492 and 1.496. It boils between 143° and 145° F. In water chloroform dissolves but slightly, but it imparts to it its peculiar odor and taste. It is miscible in every proportion with spirits of wine and ether; on mixing with the latter, heating takes place. On mixing chloroform with caustic potash lye and very moderately heating, it is completely decomposed, an odor of hydrate of chloral becoming perceptible, and potassium chloride and potassium formate being at the same time formed.

In working with fluids containing chloroform, great care should be exercised. Used externally, chloroform in consequence of its volatility produces a strong sensation of cold, and, by continued strong rubbing, burning and reddening of the skin. Inhaling vapors of chloroform for some time causes unconsciousness, which under all conditions has disagreeable consequences, and may even prove fatal.

When chloroform is shaken in a perfectly clean, glass-stoppered vial with an equal bulk of sulphuric acid, no color should be imparted to either liquid after remaining in contact for 24 hours. Should a coloration appear the chloroform is not pure. If 5 cubic centimeters of purified chloroform be thoroughly agitated with 10 cubic centimeters of distilled water, the latter when separated should not affect blue litmus paper (absence of acids), nor test-solution of nitrate of silver (chloride), nor test-solution of iodide of potassium (free chlorine).

Carbon disulphide is obtained by passing sulphur vapor over red-hot charcoal. Pure carbon disulphide is a transparent, colorless liquid of great refractive and dispersive power, of a pure, ethereal, chloroform-like odor, and a cooling, aromatic taste. The smell of the ordinary article is offensive. Carbon disulphide burns with a blue flame, forming carbon dioxide and sulphur dioxide. It becomes explosive when its vapor is mixed with air. Its specific gravity varies between 1.268 and 1.270 at 59° F. It boils under ordinary atmospheric pressure at 115° F. The vapor of carbon disulphide is highly inflammable, it igniting on contact with a glowing substance (for instance a cigar), and hence the greatest care should be used in handling it.

Carbon disulphide suffers partial decomposition by light, and is, therefore, best kept in a dark room. Only traces of it are soluble in water, but it imparts to the latter its peculiar odor and taste. It is also only partially soluble in dilute spirits of wine, but is miscible in every proportion with 90 per cent. spirits of wine, ether, essential and fat oils.

Carbon disulphide is an excellent solvent for a large number of substances, especially for resins, balsams, caoutchouc, gutta-percha, paraffin, and wax.

For the purpose of testing carbon disulphide the following directions will be sufficient. On evaporating it leaves behind some sulphur, which is due to the spontaneous decomposition of the fluid. On shaking with water the latter should not change blue litmus paper. On shaking with a solution of acetate of lead the mixture should not turn black or brown.

Light coal oil.—Of the readily volatile products obtained in the distillation of coal tar, the portions passing over up to 230° F., which contain the greatest quantity of benzol and are used for its preparation, are first caught. What passes over between 230° and 248° F. is brought into market as the so-called *light oil.* The specific gravity of this product varies between 0.905 and 0.910. It may be used without further treatment for dissolving resins, etc., but a product especially suitable for the manufacture of lacquer is obtained by treating the light oil successively with potassium chromate, pyrolusite, and sulphuric acid. The specific gravity of the oil thus obtained is 0.880; it is clear as water and should not turn yellow. The first volatile products obtained in the fractional distillation of crude petroleum very much resemble light oil in their exterior properties. The following table by Thœrner shows their specific gravities, boiling-points, and uses:—

Name.	Specific Gravity.	Boiling-point.	Use.
Cymogene . .	—	from 32° F. on.	For the preparation of ice.
Rhigolene . .	0.625	122° F.	—
Naphtha or petroleum-ether	0.670 to 0.675	122° to 140° F.	Extracting agent.
Benzine . . .	0.680 to 0.700	140° to 176° F.	do.
Artificial oil of turpentine .	0.740 to 0.745		Cleansing oil.

These products are less suitable for the manufacture of lacquer than the light coal oil. If their use is prescribed in any of the receipts given later on, it is advisable to substitute a corresponding quantity of light oil for them.

There is also found in commerce a benzine prepared from brown coal, which, however, cannot be recommended. It has an odor reminding one of radishes and onions.

Oil of turpentine is obtained by distilling the oleoresinous exudation of various species of *Pinus.* In the manufacture of varnishes only the purified, entirely colorless product should be employed. Such oil of turpentine can only be prepared by repeated distillation of the crude product with steam, and the addition of a small quantity of quicklime.

Purified oil of turpentine is a limpid, mobile, clear, and colorless fluid of a peculiar, penetrating odor and a specific gravity of 0.860 to 0.890. It boils between 313° and 315° F. When cooled to —16.5° F. it separates a delicate, white, crystalline body. Oil of turpentine consists solely of carbon and hydrogen, By the action of air and light it becomes yellowish to brownish and separates a brownish body; in this state it also contains oxygen. Such partially resinified oil can only be restored by repeated distillation with steam over quicklime.

The following determinations suffice for testing oil of turpentine. Blue litmus paper should not be reddened by it. The oil should dissolve in 10 to 12 parts of 90 per cent. alcohol. If a perfectly clear solution is not obtained, it is an indication of adulteration with benzine. A drop of the oil evaporated upon a glass plate at the heat of the water bath should not leave a residue. By shaking oil of turpentine with equal parts by volume of water of ammonia, the mixture on being allowed to repose should separate into two clear, colorless layers.

Oil of turpentine should be kept in well-closed vessels, and, if possible, in a dark room.

5. *Coloring-matters.*

Resins or gum-resins are chiefly used for the preparation of colored lacquers. In some cases an article painted with a color mixed with varnish is coated with a colorless lacquer, but in comparatively few cases are lacquers rubbed with earth colors. For oil paints mineral colors are used.

The following resins, gum-resins, and similar substances are chiefly used: *Dragon's blood, turmeric, sanders-wood, gamboge, annotto, saffron, grain-lac, indigo.*

Dragon's blood.—There are several distinct and well-defined varieties of resin known under the name of dragon's blood. Each variety is probably derived from a different genus, but there is probably no difference in resins derived from different species of the same genus.

An East Indian resin is at the present day the most common commercial resin of dragon's blood. It is procured from the fruits of a rotang palm, *Calamus Draco*, Willd. The resin which exudes on the fruits is separated by beating these in a sac, and then sifting out the fruit scales and other refuse. The resin is next softened by exposure to the sun, or warming in a vessel plunged in hot water, and then moulded into sticks or balls, which are wrapped in a piece of palm leaf. An inferior kind is obtained by boiling the pounded fruits.

Two kinds are exported, "*reed*" and "*lump*," of which the former is the finer.

Dragon's blood is of a dark red-brown color on the surface, of a brighter red, glossy, and somewhat porous internally, transparent in very thin splinters, and breaks with a resinous but irregular fracture, caused by the fruit scales and other impurities which are always present—in largest proportion usually in lump dragon's blood. Its specific gravity is 1.196. The pure resin, the quantity of which in the commercial article varies between 60 and 90 per cent., is readily soluble in alcohol, benzol, chloroform, acetic acid, and petroleum, but almost insoluble in ether and oil of turpentine.

As adulterations of dragon's blood dammar and colophony may be mentioned, which are generally added in preparing the resin for market. Both are readily detected by treatment with ether or oil of turpentine. In the poorer qualities the admixed foreign resins can frequently be recognized by the naked eye.

Turmeric.—This body is the rhizome of a perennial plant indigenous to India and extensively cultivated throughout Southern Asia and in many islands of the Indian Ocean. Two principal varieties are known, *Curcuma longa* and *C. rotunda.* The two varieties are externally covered with a yellowish-gray, soft and friable corky layer, and break with a short and smooth fracture of a horny or resinous lustre. The interior is of a gamboge to brown-yellowish color, the centre usually of a deeper tint and separated from the outer portion by a circular line. The nearly uniform color and glossy appearance of the interior are due to the scalding of the rhizomes previous to drying, whereby the starch has been converted into a pasty mass. The quality of turmeric is approximately judged by the brightness of the tint and the degree of lustre upon the fracture. Turmeric has a peculiar aromatic odor and a warm, aromatic and bitterish taste.

Curcuma longa, or long turmeric, is 1 to 2 inches long, ¼ to ½ inch thick, straight or curved, mostly simple, nearly cylindrical and somewhat annulated by the leaf scars. *Curcuma rotunda*, or round turmeric, attains a length of 1½ to 2 inches with a diameter of 1 inch or more; it varies in shape between globular, oblong, and pyriform, has annular marks from the scars of the leaf-sheaths, and is beset with root scars and a few fibres or their remnants.

The rhizomes contain a yellow coloring-matter which is readily soluble in spirits of wine, light coal oil, and ether, but insoluble in water.

Alkaline lye dissolves the coloring-matter with a reddish-brown color; by adding an acid, the coloring-matter is again separated from the solution.

Commercial turmeric powder is frequently adulterated with pea-meal, which can be detected only by a microscopical examination.

The coloring-matter of turmeric is not constant, it being bleached by the sun, and hence its use becomes more and more limited.

The principal commercial varieties of turmeric are Chinese, Bengal, Madras, Java, and Cochin turmeric, the Chinese being considered the best.

Sanders-wood.--Lignum santali rubrum, or red sanders-wood, is sometimes confounded with sandalwood. It is the wood of *Pterocarpus santalinus*, indigenous to the mountainous portions of the East Indies. The wood is hard and heavy; the interior is of a blood-red color and the exterior more brown-red or brownish. Sanders-wood is brought into the market in large logs and sometimes in fine chips and in a coarsely or very finely powdered state. The powder is frequently adulterated with red chalk, which may be determined as follows: Triturate about 2 grammes of the powder with, at the utmost, 10 drops of water, so that an intimate mixture is formed, and shake with chloroform. After reposing for some time the wood will be found floating upon the chloroform, while the mineral admixtures have settled on the bottom. The taste of the powder should also be tested. It should not be bitter, nor sweetish, or astringent. On incinerating the powder, at the utmost 1.5 per cent. of ash should remain behind.

Sanders-wood yields fluids of different colors according to the solvent with which it is treated. Weak alkaline lyes give a red-violet solution, spirits of wine a bright red, ether a yellow, and water one of a scarcely perceptible yellow-red color. By diluting the alcoholic solution with water it becomes yellowish, and by heating the alkaline solution it acquires a brown color.

Gamboge.—This is a gum-resin obtained from *Garcinia Hanburii*, Hooker, a medium-sized tree indigenous to Siam, Cambodia, and Cochin China. It is obtained by making incisions in the bark of the tree, the resin being collected in the joint of a bamboo, occasionally also in other vessels, where it is allowed to harden. The resin hardened in bamboo joints comes into commerce in cylindrical sticks, 6 to 8 inches long and 1 to 2 inches in diameter, called "pipes." The resin collected in other vessels is broken up in small pieces. The surface of the "pipes" is striated longitudinally from impressions of the bamboo, and occasionally contains some splinters of it. Gamboge breaks easily with a flattish, conchoidal, smooth fracture, of a deep orange-red tint, and of a waxy somewhat resinous lustre; thin splinters are slightly translucent. It yields a bright yellow powder, and on being triturated with water a uniform bright yellow emulsion is readily obtained. The content of resin varies between 80 and 87 per cent.; the content of mucous substance between 10 and 12 per cent.; the rest is moisture. Gamboge is inodorous, but the dust is sternutatory, and has a disagreeable acrid taste. Inferior qualities of pipe gamboge are of a brown or gray tint, harder, of a dull earthy or irregular fracture, and less inclined to produce a uniform emulsion.

Gamboge is sometimes adulterated with rice flour, sand, and ground bark. Such sophistications are recognized by treating the resin reduced to a fine powder with 60 per cent. spirits of wine.

Annotto.—This coloring-matter is obtained from the seeds of *Bixa Orellana*, Linn., a medium-sized tree indigenous to tropical America. The seeds are soaked or allowed to ferment in water, rubbed between the hands and upon a sieve, crushed and finally completely mashed, and again washed with water. The coloring-matter subsides and is formed into cakes.

According to the manner of packing, there are distinguished :—

East Indian annotto; thin, quite dry cakes of a disagreeable odor.

mountainous portions of the East Indies. The wood is hard and heavy; the interior is of a blood-red color and the exterior more brown-red or brownish. Sanders-wood is brought into the market in large logs and sometimes in fine chips and in a coarsely or very finely powdered state. The powder is frequently adulterated with red chalk, which may be determined as follows: Triturate about 2 grammes of the powder with, at the utmost, 10 drops of water, so that an intimate mixture is formed, and shake with chloroform. After reposing for some time the wood will be found floating upon the chloroform, while the mineral admixtures have settled on the bottom. The taste of the powder should also be tested. It should not be bitter, nor sweetish, or astringent. On incinerating the powder, at the utmost 1.5 per cent. of ash should remain behind.

Sanders-wood yields fluids of different colors according to the solvent with which it is treated. Weak alkaline lyes give a red-violet solution, spirits of wine a bright red, ether a yellow, and water one of a scarcely perceptible yellow-red color. By diluting the alcoholic solution with water it becomes yellowish, and by heating the alkaline solution it acquires a brown color.

Gamboge.—This is a gum-resin obtained from *Garcinia Hanburii*, Hooker, a medium-sized tree indigenous to Siam, Cambodia, and Cochin China. It is obtained by making incisions in the bark of the tree, the resin being collected in the joint of a bamboo, occasionally also in other vessels, where it is allowed to harden. The resin hardened in bamboo joints comes into commerce in cylindrical sticks, 6 to 8 inches long and 1 to 2 inches in diameter, called "pipes." The resin collected in other vessels is broken up in small pieces. The surface of the "pipes" is striated longitudinally from impressions of the bamboo, and occasionally contains some splinters of it. Gamboge breaks easily with a flattish, conchoidal, smooth fracture, of a deep orange-red tint, and of a waxy somewhat resinous lustre; thin splinters are slightly translucent. It yields a bright yellow powder, and on being triturated with water a uniform bright yellow emulsion is readily obtained. The content of resin varies between 80 and 87 per cent.; the content of mucous substance between 10 and 12 per cent.; the rest is moisture. Gamboge is inodorous, but the dust is sternutatory, and has a disagreeable acrid taste. Inferior qualities of pipe gamboge are of a brown or gray tint, harder, of a dull earthy or irregular fracture, and less inclined to produce a uniform emulsion.

Gamboge is sometimes adulterated with rice flour, sand, and ground bark. Such sophistications are recognized by treating the resin reduced to a fine powder with 60 per cent. spirits of wine.

Annotto.—This coloring-matter is obtained from the seeds of *Bixa Orellana*, Linn., a medium-sized tree indigenous to tropical America. The seeds are soaked or allowed to ferment in water, rubbed between the hands and upon a sieve, crushed and finally completely mashed, and again washed with water. The coloring-matter subsides and is formed into cakes.

According to the manner of packing, there are distinguished :—

East Indian annotto; thin, quite dry cakes of a disagreeable odor.

Cayenne annotto; moist cakes of a still more disagreeable odor; they are enveloped in bast.

Brazil annotto occurs in reed mats lined with palm leaves.

Stick annotto; dry, cylindrical masses.

Annotto forms a more or less soft, pasty mass of a blood-red color, becoming harder and red-brown on exposure. It has a peculiar odor and a disagreeable, saline, and bitter taste. To keep it moist it is moistened with urine, and hence its disagreeable odor and the delicate white coating of ammoniacal combinations frequently found upon it. Annotto is nearly insoluble in water, but colors it yellow, and dissolves almost completely in alcohol, ether, fixed oils, and alkalies, with an orange-red or dark-red color. When treated with concentrated sulphuric acid it becomes first dark blue, then green, and finally violet.

Adulterations of annotto with ochre, brick-dust, sand, gypsum, and the like are discovered by their insolubility in hot alcohol. One of the most disgusting impurities is the moistening with urine. Such an annotto on being heated with soda solution gives a perceptible ammoniacal odor.

Saffron consists of the stigma of the saffron plant, *Crocus sativus*, Linn., which is indigenous to Oriental countries and has been cultivated from an early period. Each stigma is 1 to 1¼ inches long, flattish tubular, almost filiform below, gradually enlarged above, slit on the inner side, and with several roundish teeth on the edge. Dried saffron is flexible and tough, of a brownish-red or orange-brown color, somewhat unctuous to the touch, of a peculiar aromatic odor, and a bitter, aromatic, and warm taste. It retains about 12½ per cent. of moisture, and, after this is expelled, becomes friable and more readily pulverizable. When chewed it tinges the saliva deep orange-yellow.

Cake saffron occurs seldom in commerce. In its loose condition it is sometimes called *hay saffron.* Several varieties are distinguished. *Spanish saffron* is usually collected with considerable portions of the styles, which are readily distinguished by their yellow color. *French or Gatinais* saffron is mostly of a better quality. The excellent saffron collected in eastern Pennsylvania is known here as *American saffron*—a term which in other parts of the United States is used to designate the florets of *Carthamus tinctorius.*

Saffron is subjected to numerous adulterations. The appearance of an inferior quality is sometimes improved by oil or by glycerin; it then leaves a greasy stain on being slightly pressed between paper. Partially exhausted saffron, which is frequently mixed with good saffron, is recognized by the lighter and more uniform color of the stigmas. The tubular florets of *Carthamus* are readily distinguished by their five-toothed corolla and the projecting anthers with style. Fibres of dried and smoked beef have also been known to occur as adulterations, and in fact of late years the sophistications have been made with such ingenuity that it requires tedious tests with the assistance of all possible technical agents to establish their presence. As at the present time other coloring substances are known which form very good, but decidedly cheaper, substitutes for saffron, the latter is now but little used in the preparation of lacquers.

Stick-lac has been mentioned under shellac. The coloring-matter of lac is soluble in water, and forms with metallic oxides insoluble lacquers of different colors, according to the nature of the metal used.

Indigo.—This magnificent blue coloring-matter is obtained from the indigo plant, *Anil indigofera*, indigenous to the Indies, but also cultivated in other tropical countries. Dealers divide it into a large number of varieties, and it should always be bought in pieces, the powdered article being frequently much adulterated. A good quality of indigo should show a mealy fracture, not solid and hard. When rubbed with a smooth article it should give a copper-red lustrous streak. In the manufacture of lacquer indigo is of importance only as a body color, since the solution effected with sulphuric acid cannot be added to lacquers.

Indigo-carmine is obtained from indigo by the following process: Place in a porcelain or earthenware pot 1 part of best indigo finely pulverized, 1 part each of fuming and of ordinary sulphuric acid. Stir constantly to avoid too strong heating, then cover the vessel and let it stand for 24 hours. When all the indigo is dissolved, which may be recognized by a drop taken from the pot and thrown into a glassful of water, coloring the latter blue without forming a precipitate, pour the solution into water, dilute it with ten times its volume of water, filter, and precipitate the indigo-carmine with carbonate of potash or soda as long as effervescence continues. Collect the precipitate upon a filter of wool or felt and allow to drain off. Pure indigo-carmine is soluble in pure water, but not in water containing salt.

To color varnish with indigo-carmine the latter is triturated with varnish upon the pounding-stone and sufficient varnish is gradually added to form a fluid mass, and this is stirred together with the rest of the varnish.

With the exception of indigo, the above-mentioned coloring-matters are used in the manufacture of lacquers only on account of the solubility of the actual coloring-matter contained in them in alcoholic, ethereal, and oily liquids. As covering-colors, numerous mineral colors are also employed. The finest qualities should, of course, be selected, and for alcoholic lacquers to be triturated with covering-colors, only the lightest coloring-matters should be taken; the heavier mineral colors deposit too readily, and, after long standing, form a dense sediment which cannot again be uniformly mixed with the fluid.

Aniline colors.—In the use of these colors great care should be exercised, since in the manufacture of lacquers substances generally occur which chemically affect a number of aniline colors, whereby the tone of color is changed and even entirely destroyed. Aniline colors are prepared on a large scale in special factories, particularly so in Germany. These colors are produced from coal-tar, and are obtained of all shades and tones. When they are added to varnishes the resulting color is bright, beautiful, and sparkling, especially so when applied to a metallic surface. These beautiful colors, however, are not stable, and, therefore, it is better to employ lacquers and varnishes colored with organic bodies, such as the dye-woods, etc., when a colored durable varnish is required.

A peculiar kind of lacquer which is prepared with the assistance of aniline colors, the so-called *resinate colors*, will be described later on.

The coloring of lacquers and varnishes by means of colored, transparent, metallic combinations, may be effected by combining in a suitable manner the respective metallic oxides with resinous substances, which are of an acid nature. Such colored lacquers will also be described later on.

DIRECTOR OF INDUSTRIES
Bengal

III.

OXIDIZING AGENTS (DRIERS) FOR CONVERTING OILS INTO SICCATIVE OR BOILED OILS.

THE property of drying oils to become hard in a certain time when exposed in thin layers to the air, is increased by certain metallic compounds to such a degree that they dry in a comparatively short time. The preparation of siccative or boiled oils entirely depends on a suitable treatment of the drying oils with metallic compounds.

The compounds of three metals, viz., of lead, manganese, and, to a limited extent, of zinc, are especially suited for this purpose.

COMPOUNDS OF LEAD. 1. *Litharge.*—This is the monoxide of lead. It is also called massicot, and, according to its lighter or darker color, silver or white litharge or gold or red litharge. It is formed by heating lead in contact with air, a film being thereby formed upon the surface of the metal, which is renewed as fast as removed, and so on until all the lead has been oxidized. On a large scale litharge is obtained as a by-product in extracting silver from argentiferous lead, and is freed from small particles of lead mechanically mixed with it by grinding and washing.

Pure litharge is a yellow powder, sometimes of a lighter or darker color. It fuses at a strong red heat, and when cold solidifies into scaly, crystalline masses.

2. *Red lead, red oxide, or minium.*—This is also an oxide of lead, and contains more oxygen than the common monoxide. It is manufactured by carefully heating litharge in contact with the air until it is brought nearly to its point of fusion, but without allowing the heat to rise to the melting-point of litharge. The monoxide continues to absorb oxygen from the air, and is gradually changed into a powder of a peculiar red color, which is used as a paint, and also as a very durable cement for glass and water conduits.

3. *Sugar of lead or acetate of lead.*—This is a crystallized salt, which is obtained by dissolving litharge in vinegar and evaporating the solution. The crystals have an intensely sweet taste, but a very disagreeable, metallic after-taste. They are poisonous like all other compounds of lead, and when exposed to the air become covered with a white efflorescence. On dissolving sugar of lead in water a portion may remain undissolved, and the fluid will have a milky appearance. In such case an insoluble acetate of lead has been formed, but it can in a short time be entirely dissolved by adding a small quantity of vinegar to the fluid, and heating.

Disadvantages of lead compounds.—Although compounds of lead produce siccatives which leave nothing to be desired as regards their drying qualities, they possess the disagreeable property of having an uncommonly strong tendency towards combining with sulphur, the sulphide of lead thus formed being of a black color. Small quantities of sulphuretted hydrogen, which is generated in cesspools and manure heaps, are always present in the air of our dwellings, even the human cuticle secreting small quantities of it. Therefore, siccative oils prepared with a lead compound when exposed to the air will soon absorb sulphuretted hydrogen and acquire a darker color. This change may be readily observed by the difference in appearance of an object painted white and varnished a few months ago from one freshly painted and varnished. While the latter will present a pure white color, the former will have acquired a yellow tone from the lead in the siccative oil having been partially converted into sulphide of lead.

But a still greater disadvantage arises when a siccative oil prepared with lead is to be used with different artists' colors; some of these colors, for instance, cadmium yellow, cinnabar, etc., consisting of sulphur combinations. Now, if by means of such a color siccative oil is brought into intimate contact with sulphur, a reciprocal action takes place in a short time between the lead in the siccative oil and the sulphur in the color, the result being always the formation of black sulphide of lead, whereby the pigment loses its beauty and lustre, and in a short time assumes a smoky appearance.

An excellent substitute for the lead combinations, as far as the fabrication of lacquers and varnishes is concerned, has been found in the

Compounds of manganese.—Manganese is a metal closely resembling iron in its properties. The most valuable ore of manganese is the peroxide or dioxide, the mineralogical name of which is *pyrolusite.* It furnishes the raw material for preparing the compounds of manganese, or, should it be preferred not to use this body, the sulphate of protoxide of manganese can be bought in a pure state in the stores. It forms beautiful rose-colored crystals, soluble in water.

To dissolve pyrolusite, heat it in a vessel of stoneware or glass together with hydrochloric acid, whereby considerable quantities of chlorine are disengaged. Where chlorine can be profitably employed, it may be recommended to work in this manner, otherwise it is more convenient to use the sulphate of the protoxide.

Hydrate of protoxide and protoxide of manganese.—These compounds are formed by adding caustic potash to a solution of manganese in water. The whitish-gray precipitate which is formed is collected upon a filter, washed eight or ten times with water, and dried. During this process air must, however, be excluded, as the protoxide eagerly absorbs oxygen from the air, being thereby changed into sesquioxide, which may be recognized by the precipitate acquiring a brown color. For this reason the protoxide is less frequently used as such, but is generally liberated from a compound only at the moment when it shall act upon the oil. How this is accomplished will be explained later on.

Hydrate of sesquioxide and sesquioxide of manganese are formed by preparing the hydrate of the protoxide in the above-described manner; but the precipitate is allowed to dry in the air, whereby it is changed into the hydrate of the sesquioxide by absorbing oxygen. The hydrate thus formed is freed from water by gently heating it, and thus the sesquioxide of manganese is obtained. The pure sesquioxide is a soft, dark-brown powder.

Permanganate of potassium is found in commerce in beautiful dark-red crystals, forming, when dissolved, a deep purple liquid. It readily evolves oxygen.

Borate of manganese is the most important of the compounds of manganese used in the manufacture of siccative oils. It may be obtained in commerce in a sufficient state of purity for this purpose, but it is so easily prepared that it is of advantage to the manufacturer to prepare it. The process differs somewhat according to whether pyrolusite or manganese sulphate is used.

From pyrolusite it is obtained by dissolving the latter by boiling with hydrochloric acid. The solution is next evaporated in a porcelain dish until it seems to contain but little acidity, when solution of soda in small portions is from time to time added to it. After the first portions of the soda solution have been added the fluid effervesces, and the precipitate formed is immediately re-dissolved. This is continued as long as any free acid is present. Should the precipitate not re-dissolve even if thoroughly stirred up, add carefully a small quantity of the soda solution. This addition of soda solution is entirely discontinued when the precipitate formed in a sample of the fluid is perfectly white, which proves that the fluid contains no more sesquioxide of iron. If the latter were present, the borate of manganese would be colored brown. The fluid is then filtered and a hot solution of borax added as long as a white precipitate is formed. This precipitate, consisting of pure borate of manganese, is filtered off and washed with hot water until a drop of the wash water leaves no perceptible residue when evaporated upon a watch crystal. The funnel containing the salt is then covered with filtering paper and the borate of manganese dried.

From the sulphate of protoxide of manganese the borate is prepared as follows: Dissolve 1 lb. of the sulphate in 6 pints of distilled water, and filter the solution if cloudy. Then test a few drops of the liquid with caustic soda solution; the precipitate formed should be white. If it shows a greenish, yellowish, or grayish hue, iron is probably present, and it will be necessary to treat the entire solution with caustic soda until a white precipitate falls, and then to filter it again. Then add a boiling saturated solution of pure borax until no more precipitate falls. Collect the precipitate upon a filter and wash with hot distilled water until the wash waters show no turbidity, when a solution of barium chloride and a few drops of dilute hydrochloric acid are added to the last portion coming through the paper. The borate of manganese is then dried in a warm place and finally in the water-bath.

Oxide of zinc is also used for the fabrication of siccative oils. It is obtained by the combustion of zinc in contact with the air, and forms a brilliant white powder. The zinc-white prepared in zinc works is a very pure oxide of zinc, and may be used without further preparation.

The quantities of the various oxidizing agents necessary for the production of a good siccative oil depend on the nature of these agents, and also on the required drying capacity of the oil. Generally speaking, less is required of the manganese preparations than of the lead compounds, the former acting more energetically. To obtain by boiling for three hours a siccative oil which will dry in 36 hours, there will, as a rule, be required of manganese preparations, 1 to 1½ per cent.; of lead preparations, 3 to 5 per cent.

These quantities must, of course, be increased if a more rapidly drying oil is required. Thus, for instance, with boiling for 5 to 8 hours, there will be required of manganese preparations, 2 to 3 per cent.; of lead preparations, 5 to 8 per cent. A further increase in these quantities cannot be recommended, because it would cause a partial saponification of the oil.

Ferrous sulphate, or copperas, is frequently added as a drier. It is found in commerce in pale-green crystals, which rapidly oxidize in the air. The crystals contain 5 molecules of water of crystallization, and hence must be dried before use.

Patent drier.—Dried zinc sulphate, 7½ parts by weight; lead acetate, 2; litharge, 3½; mix them with boiled oil, 2 parts by weight, and grind well together.

Mix Paris-white, 50 parts by weight, and white lead, 25, with boiled linseed oil, 30, and mix them with the first mixture, adding sufficient boiled oil to give the mass the consistence of soft dough.

Zumatic drier.—Zinc-white, 25 parts by weight; borate of manganese, 1. Grind the two ingredients together. In this mixture the manganese salt alone acts as a drier. Considered from a chemical standpoint, the only advantage of the addition of zinc-white would be that the peroxide of manganese is separated from the borate by the zinc. It is, however, an open question whether this is actually the case.

IV.

DISSOLVING, ROASTING, AND DISTILLING OF RESINS.

MOST resins can be dissolved without much difficulty in the suitable solvents, provided they are finely powdered and by a simple device prevented from caking together. But amber and copal, as previously mentioned, require special preparation to render them soluble, none of the known solvents completely dissolving these resins under ordinary circumstances.

Dissolving of resins.—The larger part of copal becomes soluble by continued roasting, but a certain quantity of the resin still remains behind and resists the most effective solvents. Copal, as well as amber, can only be brought into a soluble form by a partial dry distillation, frequently erroneously called "fusing." As far as the other resins are concerned, it generally suffices to reduce them to a fine powder and to dissolve them with the assistance of heat; but the entire process passes off smoothly only when the resin to be dissolved is of a uniform character. It frequently happens that some pieces of one and the same kind of resin require twice as long for solution as others, which causes a loss of time and of fuel. The dissolving property of resins corresponds with their other physical properties, pieces of equal hardness, the same color, and the same lustre generally dissolving in the same space of time. It is, therefore, recommended to sort the resins previous to dissolving, especially according to color and transparency.

To effect the solution of the resins in as short a time as possible, they must be reduced to a fine powder; but if this powder is brought without further preparation in contact with the solvent, it may cake together, and the surface of the mass formed thereby will become covered with a thick viscous solution which seriously impedes and retards further solution.

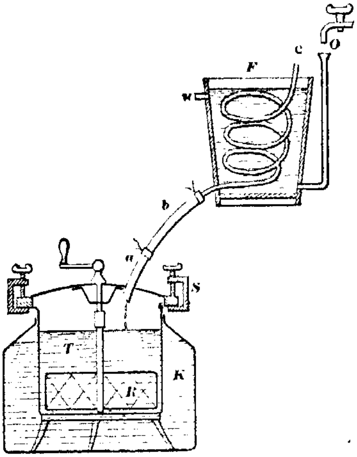
To prevent the caking together of the powdered resin it is advisable to mix it with some indifferent substance, for instance, pure quartz sand, or, if such cannot be procured, powdered glass freed from the mealy portions by being passed through a wire sieve. It is best to use equal proportions of powdered resin and glass.

To hasten solution the solvent is heated. The solvents being volatile, and some extraordinarily so, if an open or only loosely covered vessel were used for heating, a large proportion of them would be lost. Furthermore, the vapors of all these fluids are highly inflammable, and hence special precautions must be taken against danger from fire.

A cheap apparatus for dissolving resins in volatile solvents is shown in Fig. 10. It may be used with any kind of volatile solvent without the loss of any portion of the latter and without fear of danger from fire.

The apparatus consists of a pot, *T*, enamelled inside and provided with a flat rim. It stands upon a trevet in the boiler *K*, which is considerably narrower towards the top, and is filled with water. The lid is pressed firmly upon a rubber or leather ring by means of binding screws, *S*, thus making it air-tight. The mixing of the solid bodies in the vessel *T* with the fluid is effected by means of the stirring apparatus *R*. A lead pipe *a*, the end of which is cut off obliquely, is fastened in the lid, and is connected by a rubber hose with a worm lying in the cooler *F*.

Fig. 10.



When this apparatus is to be used, the water in *K* is brought to the boiling-point, and, as soon as the vapors of the solvent appear at the upper end of the pipe *c*, water is allowed to flow constantly through the upright tube *O* into the lower part of *F*. The vapors ascending through *b* condense in *c* and flow back in the form of drops through *a* to *T*. The water in *F* on becoming warm ascends, runs off at *u*, and is replaced by cold water flowing in at *O*.

The water in *K* is brought to the boiling-point only when oil of turpentine, petroleum, tar oil, or spirits of wine is used. With the use of chloroform, wood-spirit, or carbon disulphide it should not be heated above 122° F., and not above 104° F. when ether and petroleum-naphtha are employed. In the latter cases it is also advisable to throw pieces of ice into the cooling water, ordinary well or river water not being cold enough to condense the vapors.

If it is desired to make the solution of a resin in a volatile solvent more viscid, it may be readily effected by evaporating a portion of the solvent. By accomplishing such evaporation in a small distilling apparatus connected with the upper part of the worm *c*, the vapors condense in the latter and may be collected for future use.

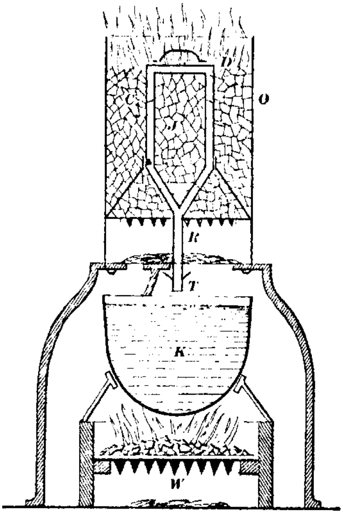
Distillation (roasting) of resins.—Amber and copal, as previously mentioned, require special treatment to prepare them for solution in solvents. By fusing they become tolerably soluble in linseed oil, but a portion is decomposed during the process. To render them entirely soluble in volatile solvents they have to be subjected to dry distillation.

The process of roasting copal is as follows: The copal reduced to a fine powder is exposed for several days (generally 40 to 72 hours) to a temperature varying between 180° and 220° F.—about the temperature of a strongly heated oven. During this roasting, bringing the resins in contact with the metal should, as much as possible, be avoided, they thereby becoming darker. It is best to use large flat dishes of stoneware or porcelain, or shallow well-enamelled iron pots.

Although copal becomes more soluble by roasting, the process is unsatisfactory to the manufacturer, who must exhaust his raw material as much as possible, and especially the more expensive resins. Better results are obtained by

Fusing the resins.—This process, on account of its practicability and simplicity, may be especially recommended to small manufacturers, as it produces fat varnishes answering all demands. By this plan the preparation of the copal and boiling of the varnish may be accomplished by one operation.

Fig. 11.



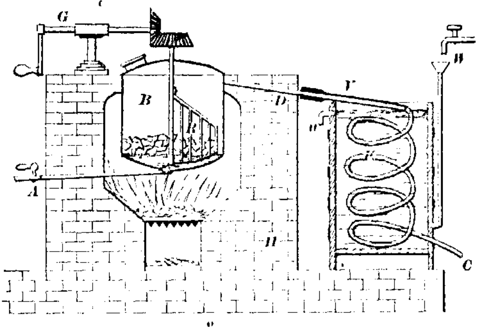
The apparatus employed for this purpose is shown in

Fig. 11. *C* is a riveted cylinder of sheet-iron with a tapering piece jointed to the bottom. The cylinder is placed upon several supports in a small furnace, *O*, which is heated with charcoal. The lid *D* fits lightly upon the cylinder, and during the operation is plastered over with clay. A copper pipe, *R*, is screwed to the tapering piece of the cylinder. The pipe passes through the grate of the furnace and the ash-pit, and is provided with a small funnel-shaped contrivance, *T*, for catching the ashes which might possibly fall down.

In the cylinder *C* stands another cylinder, *J*, of sheet-copper. This also has a tapering piece jointed to the bottom, which is perforated with a large number of small holes like the rose of a watering-pot. Small strips of sheet-copper are riveted to the cylinder *J*, and hold it in such a manner as to leave a space of about ½ inch between *J* and *C*. A boiler, *K*, is placed under the pipe *R*. The linseed oil is brought into this boiler, and is kept in gentle ebullition by a coal-fire in a small air-furnace. The cylinder *J* is filled with pieces of copal, and, after placing the lid *D* in position, the fire is started. As soon as drops of fused resin commence to appear on the open end of *R*, the linseed oil in *K* is brought to a brisk ebullition and constantly stirred. The fused oil dropping into the boiling linseed oil dissolves quite readily. Very serviceable copal lacquers are produced in this manner, but they have quite a dark color. After using the copper cylinder it should not be cleansed, the thin layer of resin adhering to the sides helping to protect it. From 21 to 26 gallons of lacquer can, at one time, be produced with this apparatus.

Larger quantities and the best quality of lacquer can, however, only be produced by subjecting the resin to dry distillation, the apparatus shown in Fig. 12, serving for the purpose.

Fig. 12.

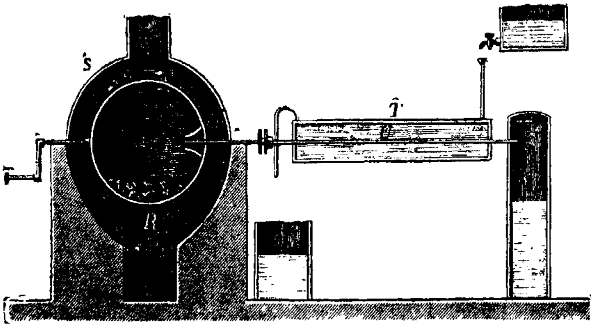


The discharge pipe *A*, which must be coated with fire-clay, is secured in the bottom of the cylindrical still *B*. The latter is bricked in the hearth *H*, and heated by an open fire. In the head of the still is an opening closed by a screw-lid, through which the resin is introduced. The contents of the still are kept in motion by a stirring apparatus revolved by the gear *G*. The pipe *D* serves for carrying off the escaping vapors, and is connected by *V* with a worm, which lies in the cooling vessel *K*. The water in the latter is kept at a low temperature by cold water flowing in at *W*, the warm water running out at *u*. According to some authorities, the inside of the still *B* should be silvered to protect it from the vapors of the fusing resin, and to be able to use the latter for light-colored varnish. The same object may, however, be attained by coating the inside of the still, when new, with a good quality of amber varnish.

Investigations by Violette have shown that copal only dissolves readily and completely when it is kept in a fused state at a temperature of 680° F. until it has lost 25 per cent. of its weight by distillation. For fusing and distilling copal, Violette has constructed and tested several apparatuses, of which only those suitable for working on a larger scale shall here be described.

Fig. 13 represents an apparatus in which 22 lbs. of copal can be worked at every operation. *Q* is a copper sphere, silvered inside, 20 inches in diameter. It rests in a brick furnace, *R*, and is covered by a movable head, *S*, which at the same time conducts the smoke into the chimney. The sphere which serves as the receptacle for the copal can be revolved around its axis by a crank, so that the fusing copal is distributed over the entire internal surface and is everywhere uniformly heated. The vapors escape through the pipe *U*, which reaches

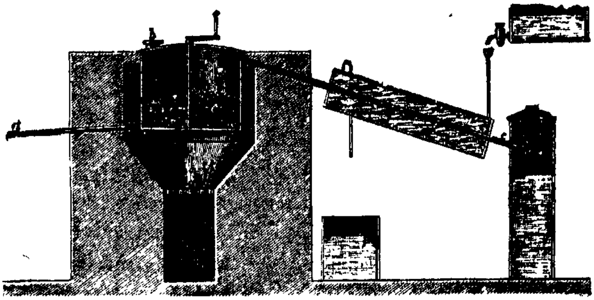
Fig. 13.



into the sphere through a stuffing-box, and lies in the cooler *T*. The products of distillation collect in the receiver, which is provided with a gauge, so that the progress of distillation may be judged by the quantity of distillate. As soon as 25 per cent. (in this case 5½ lbs.) of the weight of the copal has passed over, the operation is interrupted by lifting off the helmet *S* and removing the sphere *Q* from the furnace. To obtain a good quality of copal, the proper regulation of the temperature is of the utmost importance, and only an experienced and attentive workman should be intrusted with the work. The temperature should not be lower than necessary for uniform distillation, nor should it be too high, otherwise the copal is burnt, or at least acquires a dark color and becomes smeary.

For working on a larger scale the apparatus shown in Fig. 14 is well adapted. The copper still *a*, which

Fig. 14.



is silvered inside, sits up to the lid in the brickwork of the furnace. Through the opening *b*, which can be hermetically closed, 220 lbs. of copal are introduced. The vapors escape through the pipe *e*, and are condensed in it. During the entire operation of heating the copal is kept in constant motion by the stirring apparatus *c*, and the fire is carefully regulated to prevent overheating. As soon as a sufficient quantity of oil has passed over, the fire is removed and the fused copal drawn off through the pipe *d*.

According to later researches by Violette, amber and copal suffer the same change by heating, either by themselves or in a mixture with linseed oil or oil of turpentine, to their melting-points, the temperature required for amber being 750° F. and for copal 662° F. According to Violette's statements, no loss in weight is incurred by this process and the amber, which, by the customary method of fusing, remains behind as a resin of a deep black color, appears as in the unchanged state. On the other hand, the vapors formed in heating produce in the apparatus a considerable tension, which may increase to a pressure of 20 atmospheres. Though this pressure may be somewhat decreased by heating the resins before introducing them in the apparatus, to 572° F., in order to evaporate about 5 or 6 per cent. of water which they contain, it is doubtful whether for working on a large scale apparatuses can be constructed which will bear such pressure at the high temperature. Violette made his experiments in a closed glass tube, or in a copper cylinder silvered inside. With the use of the latter he succeeded in making 1 quart of finished varnish, a quantity which is, however, too small to allow the process being designated as one of technical use.

Lehmann's new method of boiling varnish and fusing copal by means of superheated steam.—Mr. Richard Lehmann, of Dresden, describes this process as follows:* This method consists in boiling the linseed oil and fusing the copals by means of superheated steam.

As is well known, linseed oil as well as copal has to be heated to temperatures near the limit at which decomposition of the materials takes place. In doing this the materials rise in the vessel and, if heating is carried too far, readily boil over. The dangers connected with the latter are well known. The material being in a state of decomposition ignites readily on coming in contact with the oxygen of the air or the heating gases of the fire, the result being a conflagration, which, as a rule, cannot be subdued. Even if a skilled workman can regulate the fire so that boiling over will not readily take place, he is powerless as regards leakage in consequence of the bottom of the vessel burning through, or other accidents. These dangers are completely removed by the use of superheated steam. Besides the exclusion of danger from fire, the complete removal of the disagreeable odor evolved in boiling and melting is also of great importance. It is evident that vapors which are evolved only at a temperature of about 572° F. cannot be removed by the low temperature generally prevailing in the chimney. The only effective means of destroying them is to burn them as is done in the boiling and melting processes to be described.

Fig. 15 shows the general arrangement of a steam plant for boiling varnish according to this method.

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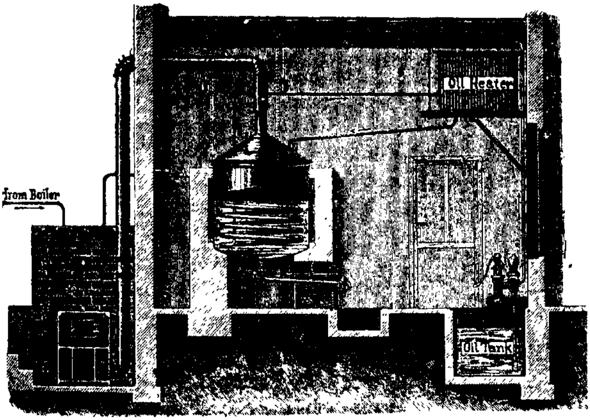
* Neueste Erfindungen und Erfahrungen, 1889, p. 15 et seq.

The steam superheater is outside the boiling-room, but as close to the kettle as possible, in order to avoid long steam conduits. To prevent loss of heat, the kettle is

Fig. 15.



bricked-in. The steam is conveyed from the boiler to the superheater, where it is highly superheated, and at a temperature of about 752° F. reaches the heating coil in the kettle, through which it yields its heat to the linseed oil, the latter being thereby very gradually and uniformly heated. A sudden rise in the temperature of the linseed oil, which cannot be avoided with the intense heat of an open fire, is here entirely precluded, the temperature of the steam being virtually not higher than the boiling-point of the oil. For the same reason a partial scorching and caking of the additions, etc., to the bottom of the boiler cannot occur.

The kettle is covered with a head suspended by chains over pulleys, so that it can be readily removed. It is also provided with a small opening through which the boiling process may be observed, additions be introduced, and the oil, if required, be stirred. The head is further furnished with a thermometer which dips into the oil, so that the temperature can be conveniently read off.

The head enters a pipe of corresponding width through which the vapors formed are conducted below the grate of the superheater, where they are sucked up and on passing through the glowing layer of coal are burned over the grate. There is no danger of the flame striking back through the pipe to the kettle, because the vapors are rapidly cooled off by their long passage through the pipe and are not inflammable in a cold state. Moreover, to prevent any possible danger from the flame striking back, there is placed where the vapors enter the ashpit, below the grate of the superheater, a fine wire netting, the effect of which is illustrated by the miner's safety-lamp.

Although in boiling oil with superheated steam boiling over is scarcely possible, there is, in case it should happen, no danger of any kind, but only a loss of material, which can be readily prevented by providing the kettle with a flow-over pipe of sufficient size through which the oil would run, without loss or injury, to a reservoir provided for the purpose.

To utilize as completely as possible the heat of the steam, which leaves the heating coil quite hot, a reservoir is arranged at a higher level than the kettle, in which the oil is preparatorily heated by the escaping steam.

The plant for fusing copal and amber for the manufacture of lacquer is based upon the same principles. It is shown in Fig. 16. The superheater in this case is also placed outside the workroom. The fusing of the copal is effected in a closed copper cylinder. The lower

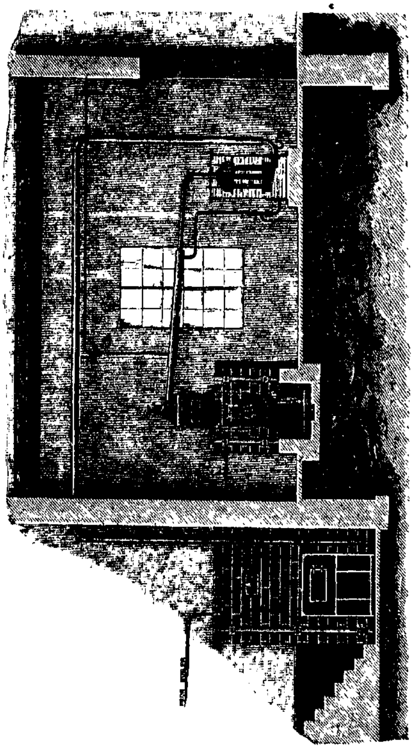


Fig. 16.

portion of the cylinder forms the actual fusing space, and is surrounded with an iron jacket in which strongly superheated steam circulates. The temperature prevailing in the fusing space is indicated by a pyrometer placed on one side.

The upper portion of the apparatus is sufficiently roomy to allow the boiling copal to rise. It is hermetically closed by a head, which, when necessary, can be taken off. In the head are two apertures for filling the cylinder, which also serve for observing the progress of fusing and for taking samples. From the head, the vapors are conducted through a cooled pipe to a cooler, where they condense to copal oil, which is caught. Non-condensing gases are conducted below the grate of the superheater and burned.

In front of the fusing plant is placed the so-called mixing vessel, in which the oil required for the solution of the fused copal is heated to from 248° to 302° F. by the waste steam from the fusing apparatus. When fusion is complete the copal is drawn off into the mixing vessel and intimately mixed with the varnish. The addition of turpentine is effected in another room after the mass has been sufficiently cooled off.

After emptying the fusing cylinder, fresh copal is immediately introduced, another mixing vessel filled with the corresponding quantity of oil, and the operation commenced anew. Thorough cleaning of the cylinder after each operation is not necessary, but may from time to time be done by boiling with soda-lye and subsequent rinsing with hot water.

V.

PREPARATION OF SICCATIVE OR BOILED OIL.

As previously stated, linseed and other drying oils possess the property of drying in a short time when exposed to the air in a thin layer. This property is still further increased if the oil is heated for some time to a temperature at which decomposition takes place or, to use the common term, is "boiled." The quickest way, however, of changing linseed oil to siccative or boiled oil is by adding a drier in the form of a metallic oxide, compounds of lead, manganese, and zinc being chiefly used for the purpose.

The operation of boiling linseed oil requires the greatest attention, as not only the entire quantity of oil boiled at one time may be lost if the work is carried on carelessly, but also conflagrations difficult to subdue may be caused by the oil boiling over and taking fire.

When linseed oil is gradually heated, it first throws off aqueous vapors, which are succeeded by vapors of a disagreeable odor, originating from the products of the destructive distillation of the oil. This decomposition is indicated by a phenomenon resembling that of boiling; the oil throws up bubbles and assumes a darker color. It is very important that the temperature should not be allowed to rise above a certain degree—about 572° F.; but many workmen do not use a thermometer, relying entirely on practical tests. Such, for instance, is the so-called feather-test, which consists in a chicken feather being dipped into the hot oil, and when this bends and shrivels up with a slight crackling noise the right temperature is supposed to have been attained.

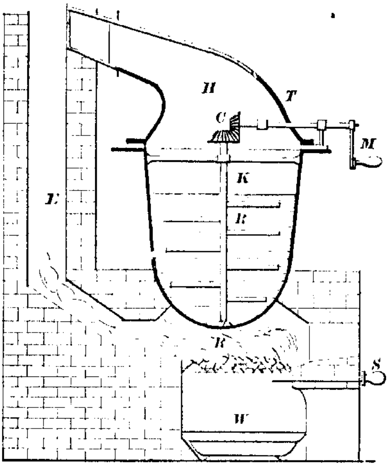
The oil should be heated only from below in such a manner that the sides of the boiler are not touched by the gases of the fire. By this arrangement excessive heating can be more readily avoided. Linseed oil, like all fat oils, is a bad conductor of heat, and, therefore, to prevent over-heating or scorching on the bottom of the boiler, the greatest care must be taken to mix, by constant stirring, the very hot oil with that which is less hot.

The motion occasioned by stirring the oil, as well as the great expansion of the oil itself when heated, requires that the vessel in which the oil is boiled should not be more than about three-quarters full.

A simple apparatus for boiling linseed oil is shown in Fig. 17. It offers the greatest security against losses from boiling over and danger of fire, and also protects the workmen from the noxious vapors. Furthermore, the fire under the boiler can be immediately extinguished in case, through careless firing, the temperature of the oil should rise so high that boiling over be feared.

The apparatus consists of the boiler *K* furnished with a stirring apparatus, *R*, which is put in motion by the bevel-gear *C* and the crank *M*. The boiler is bricked-in in a fire-place, the grate *R* of which consist of two parts moving on pivots, which are kept in position by the rod *S*. In the ash-pit of the fire-place is placed a tub, *W*, filled with water. If it is feared that the contents of the boiler may become overheated, the two parts of the grate can immediately be dropped by drawing out the rod *S*, the fuel dropping into the tub *W*, where it is extinguished.

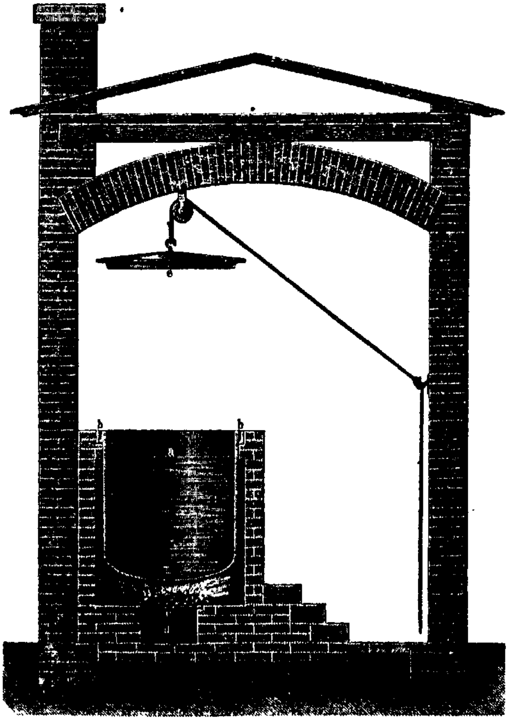
Fig. 17.



To protect the workmen as much as possible from the vapors of the hot oil, a head, *H*, is placed upon the boiler. This head passes into a pipe leading into the chimney *E*. The vapors ascending from *K* pass with the gases from the fire into the open air. The capacity of the apparatus, of course, depends on the size of the factory. When large quantities are worked at one time, the heat can be readily regulated and boiled oil of a uniform quality obtained.

Another arrangement, recommended by Andés, is shown in Fig. 18. The boiler *a*, which is heated by the fuel upon the grate *c*, is so bricked-in in the fire-place that the heating gases touch the bottom and the sides of the boiler, the latter, however, only so far that the surface of the oil is at a higher level than the points touched by the fire. To prevent all danger from boiling over a gutter, *b*, runs around the edge of the boiler

Fig. 18.



through which the oil, should it boil over, pours into another boiler placed at a lower level. The lid *e* suspended by a rope or chain serves for covering the boiler.

Siccative or boiled oils may be divided, according to the metallic compound used in their preparation, into *lead*, *manganese*, and *zinc oils*.

Lead oils.—Until within a comparatively short time compounds of lead were the chief means of converting linseed oil into siccative or boiled oil. The superiority of the highly siccative oils prepared with borate of manganese over those in the manufacture of which lead or zinc compounds are used is so decided that all description of the older and less satisfactory methods might be omitted. However, for the sake of completeness, some methods of working with these compounds will be given.

Ordinary litharge oil.—Bring the required quantity of linseed oil into the boiler and heat until scum begins to form, which should be constantly removed with a suitable implement. When the formation of scum ceases and the surface of the oil is smooth and of a dark color add, with constant stirring, for every 100 lbs. of oil 1 to 1½ lbs. of litharge reduced to as fine a powder as possible.

The litharge, previous to being added to the oil, should be thoroughly dried so as to be sure that it is entirely free from water. If it should be added while in a moist state, the oil would fly out of the boiler in consequence of the sudden development of vapor. Litharge becomes sufficiently dry when heated for about 1½ hours at 230° to 248° F., but it should then at once be added to the oil.

When the litharge has been added, the fire should be increased so as to keep the oil in constant ebullition and evolving vapors, and it should be kept at this temperature for about 2½ to 3 hours. To prevent the litharge from sinking to the bottom of the boiler, the mass should be stirred every 8 or 10 minutes. When the fluid has become so viscid as to draw threads on the stirring paddle, the fire is increased so that the oil begins to evolve heavy vapors, and the vane of a feather quickly shrivels up when the feather test is applied.

From this time on, the fire is no longer stirred, but care is taken to distribute the heat uniformly by diligently stirring the contents of the boiler, for this is the point of greatest danger in regard to the running over and ignition of the oil. When no more vapors are emitted, the stirring is discontinued, the fire is allowed to die out, and the boiled oil let stand in the well-covered boiler until it is entirely cooled off. During this time the larger portion of the undissolved litharge and a viscous mass of oil will have settled on the bottom. This sediment is allowed to remain in the boiler and is stirred through the linseed oil at the next boiling. The boiled oil is run into barrels to clear. It always holds some particles in suspension, which render it turbid; but as on account of its viscid condition it cannot be passed through closed filters, it may be strained through coarse linen, which retains the grossest parts. The longer the boiled oil is kept in the barrels the brighter it will become, since all heavy bodies suspended in it will sink to the bottom. Moreover, the drying power also increases, old boiled oil becoming dry in a few hours after its application. The drying power is still further increased by not filling the barrels entirely full and leaving the bung-holes open. It is, however, advisable to cover the latter loosely with paper to prevent dust from falling into the oil.

Lead oil prepared with red lead (minium).—Lead oil is prepared more rapidly by using minium or red lead than with litharge alone. When red lead is heated a part of its oxygen is liberated and acts upon the linseed oil as an oxidizing agent. One of the principal conditions for rapidly converting linseed oil into siccative or boiled oil is to use the compounds of lead in as finely divided a state as possible, and hence the greater expense of procuring washed protoxides and red oxides of lead should not be considered, as by using them time, labor, and fuel are saved.

Litharge and red lead oil.—A good siccative may be conveniently prepared in any large pot or boiler, without the necessity of actually boiling it, by mixing together 1 part each of litharge and red lead and $\frac{1}{2}$ part of acetate of lead. Tie 2 lbs. of this mixture in a bag of fine linen. Next bring into a boiler or pot 8 gallons of water and about 8 gallons of oil, and suspend the bag in the oil. Then heat the whole until all the water is evaporated, and filter the oil while hot through felt.

Lead oil without boiling.—Rub 1 part of acetate of lead together with 1 part of litharge, bring the mixture into a porcelain dish, cover the latter and place it upon a water-bath. In about one hour, according to the quantity of the mixture used, the latter is fused to a white mass. Add to this white mass 5 parts of water and shake vigorously. The fluid obtained after clearing is lead vinegar—a solution of basic acetate of lead. Dilute the solution with an equal quantity of water, triturate 20 parts of linseed oil with 1 part of litharge reduced to a fine powder, and mix all together. Let the whole stand quietly until two distinct layers are formed, the lower one of which consists of the solution of sugar of lead, and the upper one of siccative.

The siccative obtained in this manner has a very light color, and is so thinly-fluid that it can be filtered through cotton or felt. It may be freed, if desired, from lead, by stirring it for half an hour with dilute sulphuric acid (1 part acid, 5 parts water). The siccative at first assumes a milky appearance, but soon clears, the sulphate of lead formed sinking quickly to the bottom.

The two methods last mentioned may be especially recommended to mechanics who wish to prepare their own siccatives.

Manganese oils are prepared with manganese compounds, the borate especially furnishing highly siccative oils.

Manganese oil with borate of manganese.—This oil may be prepared as follows: Four pounds of borate of manganese, perfectly dry, free from iron—*i. e.*, pure white—and reduced to a fine powder, are gradually stirred into 22 lbs. of linseed oil, previously heated in a suitable vessel. The borate being uniformly distributed in the oil, the latter is heated to 392° F.

At the same time 2200 lbs. of linseed oil are brought into the boiler and heated until it commences to throw up bubbles. The mixture of linseed oil and borate of manganese, prepared as above described, is then allowed to run in a thin stream into the boiler, and the contents of the latter brought to vigorous ebullition for about

20 minutes. The oil is then ladled out and, while hot, filtered through cotton. It can be used at once.

Manganese borate possesses the property of converting linseed oil into siccative even at a comparatively low temperature; in fact, a temperature of 104° F. suffices for the purpose.

On a small scale the operation may be carried out as follows: Tie up in a piece of muslin or linen, 20 grains of dry and powdered manganese borate. Suspend the bag in a glass quart flask containing a pint of linseed oil, so that the bag is just covered by the oil. Insert lightly in the mouth of the flask a plug of cotton. Stand the flask in a warm place where the temperature does not fall below 104° F. nor rise above 200° F. In a fortnight's time the oil will have become strongly siccative, so that when spread in a thin layer on glass or paper it will dry up to a tough varnish within 24 hours.

No satisfactory explanation of the action of the manganese borate has been offered. But it seems probable that the absorption of oxygen by the oil is favored by the removal of certain impurities, and this the borate of manganese may effect.

The increasing specific gravity of the manganese oil as the process is prolonged may be used as an indication of the point at which heating may be discontinued.

When the oil has acquired a specific gravity of 0.945, it is generally sufficiently siccative for grinding with non-drying pigments, and as an addition to certain varnishes. For these purposes it may even attain a specific gravity of 0.96; but when it shows one of 0.99 or 0.995, it constitutes a thick varnish, which needs dilution with a suitable solvent. It may be well to remark here that the various processes for rendering linseed oil more rapidly drying may be regarded as resulting in two actions, partly consecutive, partly simultaneous. The first action, if it could or did occur alone, would yield a purified oil apt to dry quickly, but very slightly altered in composition; the second action is more profound, and gives rise to a thickened, denser product in which the drying process has already commenced. In practice, the first action occurs almost, but not quite, uncomplicated with the second, when linseed oil is heated with borate of manganese in a vessel to which atmospheric air has very limited access; the second action, which is of necessity associated with the first, takes place when a stream of air is blown through warm linseed oil, even in the absence of manganese borate, but far more quickly in its presence.

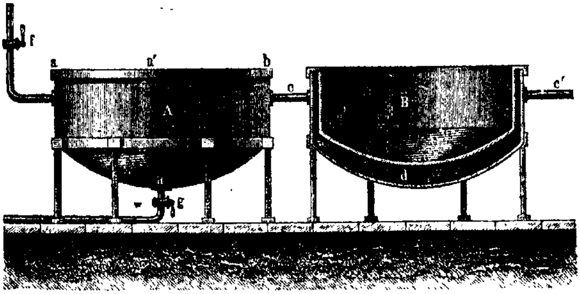
Manganese oil with sesquioxide of manganese.—Although borate of manganese yields the best results, some methods of working with other compounds of manganese will be given. For preparing oil with the sesquioxide bring 2200 lbs. of linseed oil into the boiler and heat to 158° or 176° F. Next dissolve 6 lbs. of crystallized sulphate of manganese in as little water as possible by heating in a special iron vessel. When solution is complete, take the vessel from the fire, add a solution of 22 lbs. of caustic soda in as little water as possible, stir thoroughly, and pour the mixture into the oil. The mass, at first turbid, acquires a dark color in about half an hour, becoming, however, clear at the same time. When the oil is in this condition a rubber hose with a metal rose on the end of it is plunged into the boiler and a current of air is for several hours forced through the oil. The color of the oil becomes constantly lighter, because the hydrate of the sesquioxide of manganese is decomposed and brown sesquioxide is precipitated.

The operation of converting linseed oil into boiled or siccative oil is, in all cases, accelerated by forcing air through the oil. Special apparatuses have been constructed for this purpose. They consist of a tall iron pipe placed above the boiler in which the oil is heated. The latter is lifted from the boiler by a pump, and being divided into small drops by passing through a rose, falls down through the pipe like a shower of rain. At the same time a current of air is forced through the pipe in an opposite direction to that of the falling oil.

Manganese oil with pyrolusite.—Oil of a good quality may be prepared with the peroxide or binoxide of manganese, found in nature as pyrolusite. Heat 220 lbs. of linseed oil to from 356° to 392° F., and add a mixture of 4 lbs. of finely powdered pyrolusite and 5 lbs. of sulphuric acid. This mixture when heated evolves oxygen, which promotes the oxidation of the oil and at the same time dissolves the sesquioxide of manganese in the oil. After being heated for about 1½ hours, thick milk of lime, obtained by slaking 2 lbs. of lime, is added, and after this has stood for about 12 hours, the oil is filtered through a felt funnel.

Boiling the oil with steam.—For this purpose Andés uses the apparatus shown in Fig. 19. It consists of two boilers, *A* and *B*, each surrounded by a steam-jacket, *d*. The boilers have a diameter, *a b*, of 52 inches, a depth, $a' a''$, of 26 inches, and have been tested to a pressure of 4.5 to 5 atmospheres. The steam-jackets are connected by the pipe *e*; *c′* is the pipe for conveying the steam from the boiler, *f* the blow-off pipe, and *g* the pipe for discharging the condensed water from the boiler *A*.

Fig. 19.

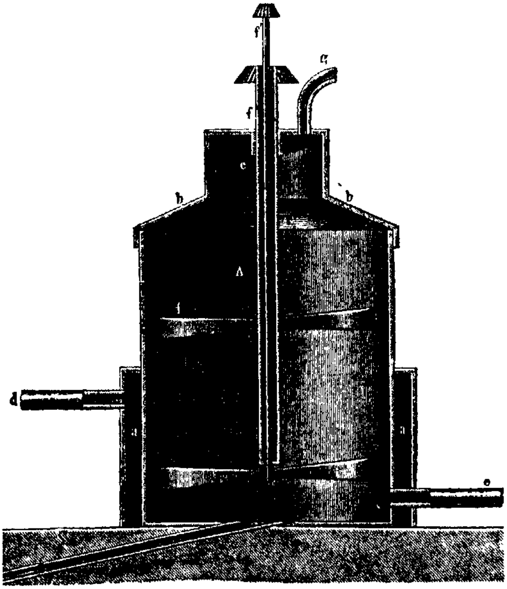


The boiler *B* is furnished with a similar pipe. Each boiler has a capacity of 770 lbs. of oil. Both boilers are filled with oil. As long as the oil is cold the steam condenses rapidly and runs off as condensed water through the open cocks *g*. As the temperature of the oil rises the discharge cocks are gradually closed, so that only condensed water, but no steam, escapes. The admission of steam is regulated so that the oil is for 5 or 6 hours kept at a temperature of from 257° to 269° F. With 12 hours' work per day, both boilers give in two days 4620 lbs. of boiled oil. To promote oxidation, a stirring apparatus which keeps the surface of the oil in constant motion may be provided.

According to F. Waltow's process patented in England, the linseed oil is boiled in open wide boilers by means of steam, then raised to a chamber also heated by steam and beaten with paddles, coming in this manner in smaller or larger drops in contact with the air and absorbing oxygen. Moreover, the chamber may be covered with glass plates to allow of the action of the light. The oil collects in a gutter near the bottom of the chamber, and, if necessary, is once more returned to the boilers.

Vincent's steam apparatus.—The apparatus used by C. W. Vincent is shown in Fig. 20. It consists of a boiler, *A*, best of copper, with a depth about equal to the diameter. Up to half its height the boiler is surrounded with a jacket, *aa*, of stout sheet-iron, steam being introduced in the space between the jacket and boiler. The boiler and jacket should be able to bear a steam pressure of 42 pounds per 0.38 square inch. The upper portion of the boiler is closed by a head, *bb*, which is provided with a manhole, *c*. Two concentric shafts, *ff*, one of which is, of course, hollow, are carried through a stuffing-box in the centre of the head and revolve in opposite directions to one another. They carry the paddles *f* and *f'*, whereby they effect a thorough mixing of the contents of the boiler. On one side of the head is a pipe, *g*, which leads to the fire-place of the steam boiler. In working the apparatus care should be taken that all the joints are tight. In this manner the escape of the disagreeable and readily inflammable vapors into the atmosphere is prevented. In the lower portion of the boiler a pipe, *e*, passes through the jacket, through which compressed air is introduced. The apparatus works as follows: The oil, generally about 4500 pounds, is first brought into a large reservoir, where it is allowed to settle. The arrangements are such that as soon as the quantity of oil to be worked at one time has been brought into the boiler, the reservoir is immediately filled up again, so as to allow the oil as much time as possible for clearing. The waste steam from the boiler is, by means of an iron coil, passed through the oil reservoir. By this preparatory heating, steam for boiling is, on the one hand, saved and, on the other, the depositing of impurities from the oil facilitated. When the oil has been thus preparatorily heated to about 95° F. it is pumped into the boiler. Steam at full pressure is then

Fig. 20.

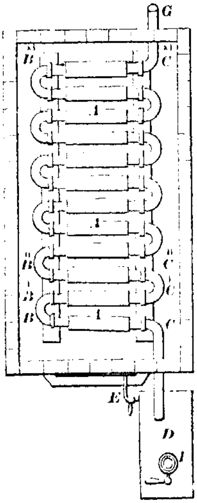


introduced and the stirring apparatus set in motion. When the pressure in the boiler has been raised to 2 or 3 atmospheres, air is admitted. Strong foaming and boiling with a considerable increase in volume take place immediately, and the previously dark-brown mass becomes pale yellow. If a dark oil is desired, the drier, in the form of a fine powder, is mixed with oil and introduced through a funnel as soon as the entire mass of the oil is uniformly heated, which is generally the case half an hour after a pressure of 2 or 3 atmospheres has been reached. After the introduction of the drier it is only necessary to see that the pressure does not get below 33 pounds, and if possible is maintained at 38 pounds, so that the air-pump which forces air into the boiler and the stirring apparatus remain in constant motion. Vincent has not determined the air required for the oxidation of a fixed quantity of oil, but as some varieties of oil require more air than others, as much air as the oil will absorb without spurting and passing over with the steam into the discharge-pipe is generally introduced. The cooling action of the air is much less than might be expected, its temperature being, during its passage, raised about 51° to 60° F. After having been treated four hours the oil is drawn off into a reservoir, where it remains until the greater portion of the drier has been deposited.

Boiling with superheated steam.—To obtain in a few hours a quickly drying oil it is necessary to raise the temperature of the linseed oil to the point where decomposition commences. However, to obtain such a temperature by the use of ordinary steam an apparatus of extraordinary strength would be required. According to Andres, steam can be heated to a temperature of over 572° F. by the use of the apparatus shown in Fig. 21, without the necessity of using vessels of extraordinary strength.

The cast-iron pipes *AA* rest upon two brick benches in a furnace furnishing a very hot flame. The pipes are connected with one another by curved copper pipes, *B* and *C*. These curved pipes are tightly driven into the pipes *A* without any other connection, and rest upon the brick benches so that the fire cannot directly strike them.

Fig. 21.



The steam passes from the boiler *DFE* at a temperature corresponding to the pressure prevailing in the boiler into the pipe system *AA*, which is kept at a red heat by the fire burning under it, and leaves the pipes at *G* with a temperature which may be above 752° F. It is a very good plan to have the superheating furnace large enough to be enabled to add a few pipes in case the steam should not be hot enough. If few pipes are sufficient, the spare room may be bricked up.

According to Andres, it is not absolutely necessary to work with steam, hot air answering the same purpose. A constant stream of air is driven into the pipe system of the above-described superheating apparatus by a fan and the air conducted back to the fan after it has yielded the greater portion of its heat to the material in the boiling apparatus; so that it may be said the work is actually done with the same quantity of air, which constantly makes a circuit between the superheating apparatus and the vessel in which the oil is boiled.

No lead pipes, but only iron or copper pipes can be used in an apparatus in which superheated steam or superheated air is employed. Copper pipes deserve the preference, as they do not produce dark-colored oil. It is also recommended to silver the metallic surface with which the oil comes in contact, but thorough enamelling serves the same purpose and is cheaper.

Lehmann's apparatus for boiling oil with superheated steam has already been described on p. 112.

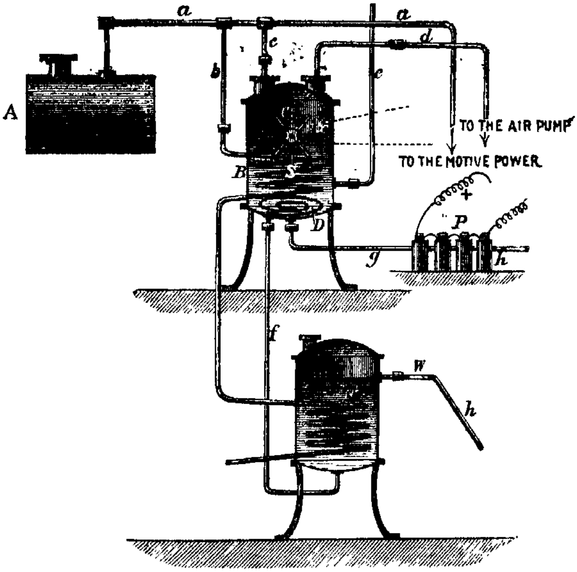
Preparation of siccative or boiled oil by means of ozone.—Drs. Schrader and Dumcke have found by a series of experiments that ozone need only act for a short time upon crude linseed oil in order to induce the formation of siccative oil and at the same time a bleaching process, these processes being afterwards finished by the exposure of the ozonized oil in shallow vessels for one day to the action of light and air. The resulting oil is claimed to be clear as water, and to dry rapidly. The gas is sucked or forced through the linseed oil, any source of ozone being available for the purpose.

Müthel and Lütke's process of preparing siccative oils by the action of oxygen-yielding mixtures of gases exposed to the action of electricity.—The preparation of siccative oil is effected by treating the oil intended for the fabrication of varnishes with various gases or gas mixtures previously exposed to the electrical action of highly oxidized and readily decomposable oxygen combinations of the metallic oxides, which break up at a moderate temperature into nascent oxygen and their lower oxides. The oxygen thus formed produces an oxidizing effect upon the fatty acid combinations brought in contact with it. Amongst others, there are suitable for this purpose a mixture of equivalent volumes of chlorine with steam; anhydrous sulphuric acid with air or oxygen in excess, or, in equivalent quantities, anhydrous sulphuric acid with hyponitric acid; nitrogen with oxygen and steam; nitrogen monoxide (N_2O) with air or oxygen.

Any one of the above-mentioned mixtures of gases is exposed in the apparatus shown in Fig. 22 to a continued vigorous electrical discharge, whereby the process of oxidation is induced. A determined formula for the resulting product, of course, cannot be given, since its chemical composition varies within wide limits from the proportional quantities of the gases, acting one upon the other. Thus, for instance, $2Cl$ must act upon H_2O so that $2HCl + O$ is formed; in like manner, when O acts upon SO_2 sufficient volumes of both must be present, that by the action of the electrical discharge S_2O_7 can be formed. In order to attain the highest stage of oxidation, it would seem advantageous to let the oxygen combination in excess act upon the higher gases to be oxidized. The apparatuses used by the inventors for the production of the oxidized gases consist of a series of so-called condensing apparatuses in which the gases are exposed to a continued complete action of electricity, as shown in the illustrations Figs. 22 and 23.

For the generation of electricity the inventors use a dynamo in the circuit of which the primary spiral of the induction-apparatus is directly coupled, while the secondary coil of the latter is connected with the condensing apparatuses, which are coupled either one after the other or alongside one another. Fig. 22 shows the arrangement of the technical apparatus. From the steam-boiler *A* a principal conduit leads to the motive power; from *a* two steam conduits, *b* and *e*, branch off. Through *b* the steam is carried to the coil *S* in the reservoir *B*. This coil serves for heating the oil introduced through the pipe *c*. On the bottom of *B* is a flat spiral pipe, *D*.

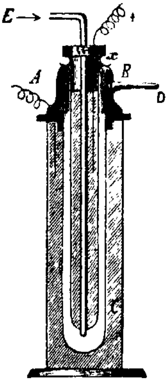
Fig. 22.



It is perforated with numerous small holes, and its continuation is formed by the pipe *g*, which leads to the oxidizing apparatus *P*, into which the gas to be oxidized is introduced through *h*.

Fig. 23 shows the oxidizing apparatus in detail. It is constructed of glass and consists of two tubes, *A* and *B*, one inserted in the other. The tubes are fused together at *x*. *A* is closed below and is placed in an iron receptacle, *C*, upon the lid of which it rests by means of a slightly projecting edge. Through the centre of the tube *B* runs a tube, *E*, to the interspace between *A* and *B*. The mixture of gas to be treated is introduced through *B*, and passing through the free space leaves the latter at *D*, to go through the same processs in a second, third, etc., apparatus. The hatched portions of the apparatus are filled with a substance conducting electricity and connected with the source of electricity by the wires + and —.

Fig. 23.



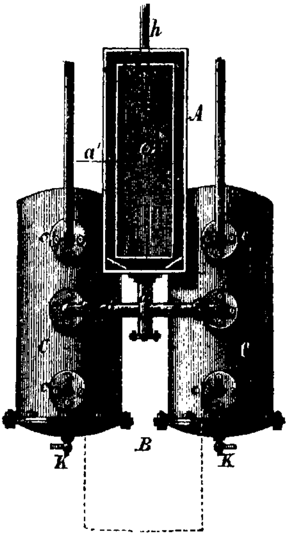
In the receptacle *B* are one or more paddles, *C*, the shaft of which passes at *x* through a stuffing-box.

The practical execution of the operation is as follows: Through *c* the receptacle *B* is filled half-full with the oil to be oxidized. By means of the steam-coil *S* the oil is then heated to between 140° and 176° F. The receptacle *B* is next connected by *d* with the air-pump, which creates a vacuum of about 73 millimeters. By now bringing the receptacle into the circuit of a dynamo the oxidizing apparatuses are connected with the induction-apparatus, while through the pipe *h* a mixture of anhydrous sulphuric acid (SO_2) with equal volumes of oxygen and atmospheric air is forced through the oxidizing apparatuses. At the same time *g'* is opened, so that the gas which has been highly oxidized in *P* is sucked in fine jets through the linseed oil, which is under a decreased pressure of air, while the paddles *C* driven by the motive power bring the oil intimately in contact with the gases. By this means the decomposition of the fatty acid combinations is very much accelerated, and a pale, thinly-fluid product is in a comparatively short time obtained, which, on exposure to the air, dries to a tough and solid mass.

The products of decomposition, carried away together with a small portion of non-used gases, may either be regenerated or simply conveyed under the fire of the steam boiler. When the oxidizing process is finished, which is ascertained by taking samples, the conduit is first closed, the stirring apparatus stopped, and after some time the conduit *d* is closed while *E* is opened. Steam now flows in, which first fills the vacuum and then, by opening *f*, forces the oil into the water apparatus *W*, which is filled half-full with slightly ammoniacal water and heated by the waste of *S* by means of the coil *S'*. By passing through *W* the oil is freed from adhering remnants of acid, and is then directly conveyed through *h* to the storage-barrels, provided it is not preferred to use first a cooling arrangement.

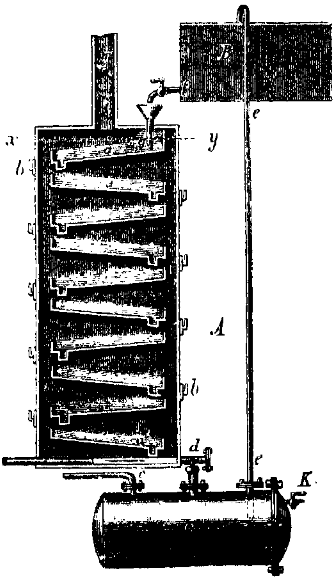
Zimmermann and Holzwich's apparatuses for the production of siccative or boiled oil.—All apparatuses or utensils with which the linseed oil or the siccative oil formed therefrom comes in contact should be made of lead or lined with sheet-lead, the addition of litharge being saved by this means. To obtain a good quality of siccative oil, the linseed oil used should be of a pale color and bleached in the air. For the preparation of siccative oil an apparatus which may be called a quick-boiling apparatus is used. It is shown in Figs. 24 to 26; Fig. 24 representing a view from above, Fig. 25 a front view, and Fig. 26 a side view. It consists of three principal portions, viz.: 1. The box *A* of sheet-iron, which serves for heating the linseed oil. 2. The iron receptacle *B* lined with sheet-lead. 3 Two closed

Fig. 24.



sheet-iron boilers *CC*, so-called *monte-jus*, also lined with lead. From the receptacle *B* the oil flows through the cock *F* and the funnel *g* into the uppermost box *a*, passes through the opening *c* into the box *a* immediately below, runs in a weak stream through all the boxes *aa*, etc., collects in the lowest box *a*, and from there passes through the pipe *dd* and its branch-pipe *dd*, which is provided with cocks, into the sheet-iron cylinder

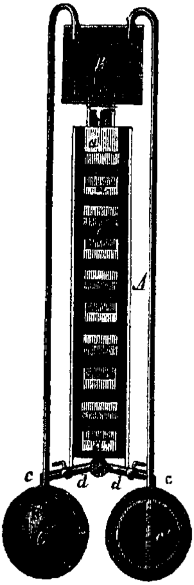
Fig. 25.



CC below. The air in *CC* escapes through the cock *K*, which must remain open while *CC* is being filled.

C' being filled with linseed oil, the latter is again pumped through the lead pipe *c* into the reservoir, to repeatedly make the same circuit through *A* and *C'* until it is converted into siccative oil. The forcing up of the oil is effected as follows: After filling a boiler its cock, *g*, is closed and the pipe *l* opened. Air is then forced by means of an air-pump upon the surface of the oil, whereby the latter is pressed upwards through the pipes *cc*. For continuous working, therefore, two boilers are required, the one being filled whilst the other is emptied. The object of connecting this apparatus with the fusing apparatus is to utilize the air still heated to 572° F., which escapes from the latter at *x*, for boiling the linseed oil. The hot air passes at *h* into the interior of *A* and yields its heat to the oil running through. From the consistency of the fluid arriving in the reservoir *B* from *C'*, it will be recognized whether the process is finished or whether the oil has to pass once more through the apparatus. Through *b* in the sides of *A* the area *aa*, over which the oil runs, can be inspected and cleansed. The vapors evolved from the boiling linseed oil are carried off by the ventilator *i*, which conveys them to the chimney.

Fig. 26.



Novelties in the treatment of oils for the preparation of varnish.—The object of this invention is to convert linseed oil and other drying oils into varnish, which is effected by exposing the oil to the action of heated air until it has acquired a syrupy consistence.

Fig. 27 represents a ground-plan, and Fig. 28 a view and partly a section of the apparatus used in the treatment of linseed oil and other drying oils. *AAA* is a series of reservoirs for the reception of the oil to be treated. Each of these reservoirs is provided with pipes, *BBB*, for the introduction of hot air. These pipes are divided into radial branch pipes, which are so arranged that they are suspended immediately over the bottoms of the reservoirs without touching them. These branch-pipes are perforated, so that the air conveyed through the conduits is forced in jets between the oil. The pipes *B* of the various reservoirs are connected with a pipe, *B′*, which is provided with hot air directly from the coil *C* in the furnace *D*.

To obtain a constant supply of air, the coil *C* is connected with a forcing-pump, *E* (preferably a Root's blower). *T* is a cock for regulating the supply of air conveyed from the blower to the coil *C*. *G* is a loaded safety-valve. The branch-pipes *BBB* are also provided with cocks, *F*, for the regulation of the conveyance of air to the various reservoirs, and for stopping the supply of air when the process has been executed in the various reservoirs. The cocks *F* and *F′* are three-way cocks, the construction of which is shown in Fig. 29. They are so arranged that the entire supply of air, or a portion of it, can be allowed to escape from the reservoir.

If, for instance, the entire series of reservoirs is in

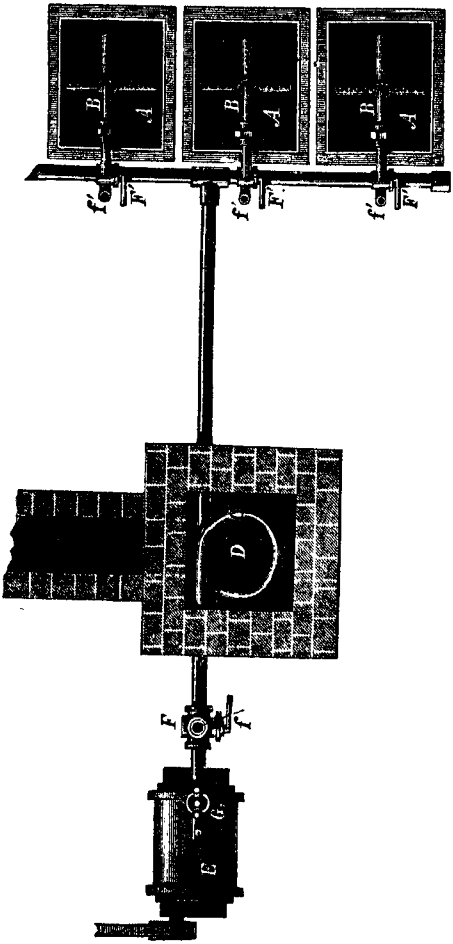


Fig. 27.

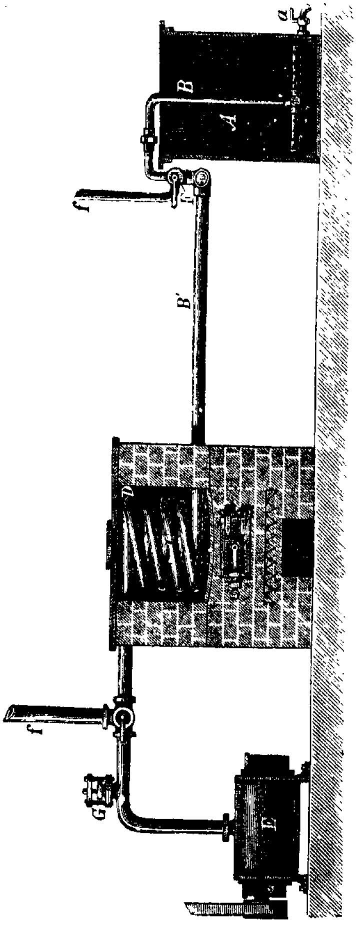
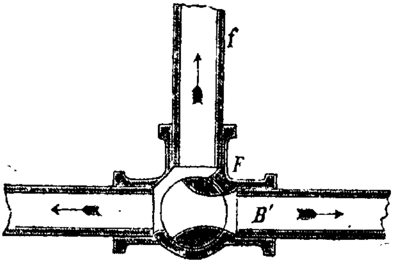


Fig. 28.

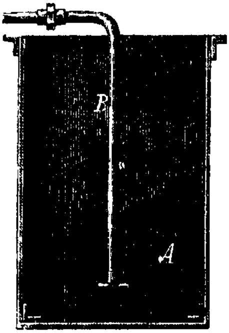
use, the maximum supply of air is required; and if the air is heated to about 594° F., the cock must be partially open. If, however, the temperature of the air in the coil is above 594° F., the cock must be opened wider to admit a smaller quantity of the air received from the blower into the outlet-pipe *F*, and a larger quantity into the coil. By this means more air is introduced into the heating apparatus and the scorching of the oil prevented. The temperature of the oil should never be above 401° F. It is most convenient to execute the operation so that the oil in the various reservoirs is at different stages of treatment, so that when the process is finished in one reservoir the oil in another reservoir may be taken in hand, and so on until the entire quantity of oil has been treated. As soon as the treatment of the oil in one reservoir is finished, the supply of heated air is stopped by turning the cock *F'*, by which an excessive increase in the temperature of the oil in the other reservoirs is prevented. If, for instance, the reservoirs contain 225 quarts of oil, a sufficient quantity of hot air is introduced to bring the temperature of the oil to about 250° F. This temperature is maintained for about 5

Fig. 29.



hours, when it is increased to about 401° F., care being, however, taken not to raise it above this point. This temperature is kept up for 5 or 6 hours to drive off the acrid vapors, their regular diminution serving as an indication that the process is finished. With the cessation of these vapors the oil suddenly thickens to a syrupy consistence. When the latter stage has been reached the supply of heated air is stopped and the oil discharged through the cock *a* into the cooling reservoir. After cooling the oil has the appearance of a pale jelly. The vapors driven off consist chiefly of olein; they may be collected, condensed, and used for various purposes. Fig. 30 shows a modification of the pipe through which

Fig. 30.



the hot air is introduced into the reservoir. The pipe ends in a *T*-piece which lies lengthwise in the reservoir. It is not perforated, but open towards both sides, so that the hot air is forced in two streams through the oil. This form of pipe is used in reservoirs which are about twice as long as wide.

VI.

PREPARATION OF OIL OR FAT VARNISHES.

A drying oil rendered more quickly drying by one or other of the processes described in the preceding chapter is often called varnish. It has acquired the property of rapidly solidifying, when exposed to the air in a thin layer, into a tough transparent mass possessing a considerable degree of cohesiveness and elasticity, yet rather soft. Although oil of this character has many uses in painting, it is not quite hard enough for some of the purposes for which a true varnish may be required; but its defects may be remedied by associating it with one or more of the resins previously described.

Fat or oil varnishes are prepared with the assistance of the hardest resins, namely, copal or amber. They present a beautiful, glossy, glass-like appearance and lose their beauty only after a long time, even if exposed to the weather. Moreover, they possess considerable elasticity and do not crack or peel off.

Copal varnish.—Apparently the simplest method of preparing fat copal varnish would be by intimately mixing copal dissolved in any volatile solvent with a good quality of siccative oil and evaporating the solvent by heating the varnish in a distilling apparatus. The solvent might be regained by condensing, while the dissolved copal would remain in the fat oil. However, such a process would require the use of thoroughly fused copal. But the cost of the latter would be considerably higher than if the work were done with the ordinary undistilled copal, as a considerable loss of volatile products is caused by the dry distillation of the resin. In practice it is therefore the aim to reduce as much as possible the loss caused by distillation. This may be done by heating the copal until it appears to be entirely melted, and endeavoring to combine the fused mass with the linseed oil.

Fat copal varnish by boiling can only be obtained of faultless quality by special skill, it being by no means easy to hit the exact moment when the copal unites with the oil. The following directions, if strictly observed, will, however, produce varnish of excellent quality.

Copal 28 to 32 parts, linseed oil 100, litharge 2 to 3, oil of turpentine 70 to 80.

The quantity of copal to be used also determines the quantity of oil of turpentine. A smaller quantity of the hard East Indian copal will be required, and more oil of turpentine may be added; but if soft copal is used, a larger quantity of it will be necessary, and the quantity of oil of turpentine must be decreased. With a variety of copal never before used, it will be necessary to determine the quantities by experiment.

Heat the linseed oil in a suitable boiler until it commences to throw up small bubbles. While keeping the oil at this temperature, melt one-fourth of the copal to be used in a small boiler over an open fire. The boiler should have ears provided with wooden handles. The melting of the copal requires the greatest care and attention. It should be constantly stirred; should the separate pieces stick together the more solid ones must be submerged in the formed fluid in such a manner as to keep everything at as uniform a heat as possible. Finally, when the resin is thoroughly melted it commences to throw up bubbles, and, on further heating, to smoke. This is the moment when the melted resin must be mixed with the hot linseed oil.

With a ladle holding about twice as much oil by weight as the quantity of copal melted at one time, the hot oil is dipped from the boiler and allowed to flow in a fine stream through the narrow spout of the ladle into the melted copal. The mass must be constantly stirred until it flows uniformly and quietly.

The small boiler containing the mixture of linseed oil and copal is then placed alongside of the large boiler to keep warm, and the same operation with another fourth part of the copal is repeated in another boiler. This boiler is also kept warm, and a third and fourth boiler containing corresponding quantities of copal and oil are taken in hand. When the work with the last (fourth) boiler is finished, all the solutions of copal are added to the linseed oil still remaining in the large boiler. The small boilers are quickly emptied in succession, and the contents of the large boiler are then constantly and uniformly stirred. A considerable quantity of viscid solution of copal remains adhering to the sides of the small boilers and must be recovered as soon as possible. When the copal solution has been poured into the large boiler a ladleful of oil of turpentine is brought into the small boiler which has first been thoroughly heated. The copal adhering to the sides is then detached and mixed with the oil of turpentine, which is best effected by means of a supple spatula of hard wood. Rattan covered with rubber is also very suitable for the purpose. When the sides of the small boilers are bright they are let stand in a warm place until the varnish in the large boiler is finished.

The linseed oil now containing the entire quantity of copal to be used must be boiled to varnish. In the receipt litharge is prescribed, but borate of manganese (0.25 part for 100 parts of linseed oil) may be substituted for it. Add the litharge or borate of manganese very gradually with constant vigorous stirring, and raise the temperature to the required degree. The scum appearing on the surface must constantly be removed.

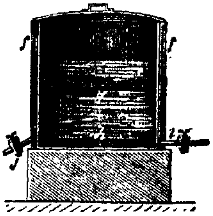
After the fluid has boiled for two hours, counting from the time when the litharge was added, it is tested. To a spatula dipped into it the varnish should adhere in a thick layer, and drop from it in transparent gold-yellow threads, becoming very thin towards the last. By the so-called drop-test, a drop of the varnish let fall upon glass should form a high arch, and when cold should be of the consistency of thick, thread-drawing syrup. As soon as this is the case, firing is discontinued, and the contents of the boiler are allowed to cool off to between 140° and 158° F. The oil of turpentine contained in the small boilers is then added.

The remaining quantity of oil of turpentine must not be added in too large portions. First about 10 per cent. of it is added and later on only 5 per cent., the varnish being tested every time after it has been thoroughly stirred. As long as the varnish is viscid after it is cold and quickly becomes thick, more oil of turpentine may be added. But if it becomes less viscid after only a small quantity of oil of turpentine has been added, the addition of the latter should be interrupted, since the quality of the varnish would be injured by adding more.

Good copal varnish should be viscid and have a light-golden color. It should run freely from the brush without forming streaks and dry in from 6 to 12 hours.

Fat copal varnish without boiling.—With the use of fused and distilled copal the preparation of varnish is more readily accomplished, the operation being very simple. Though the solution of the copal may be effected in the cold, it is much accelerated by heating to about 212° F. Heat 200 lbs. of linseed oil and 600 lbs. of oil of turpentine in a vessel by means of a steam coil and add 200 lbs. of prepared copal, which dissolves very readily. An apparatus very suitable for the purpose is shown in Fig. 31. *f f* is a copper cylinder surrounded by a wooden jacket and closed with a lid. In the centre of the cylinder rests a metal sieve. The copal is placed upon this sieve and the necessary quantity of oil is then poured in. On the bottom of the cylinder is a coil, *h*, which is connected by the pipe *i* with the steam boiler. In this apparatus solution is effected

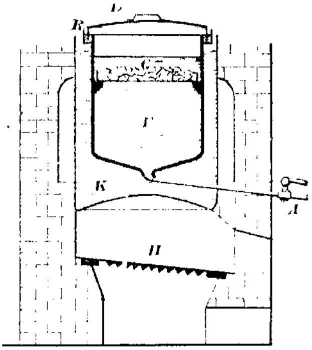
Fig. 31.



without any assistance, no evaporation of oil of turpentine taking place, and there is no danger of ignition. When the solution of the copal is complete the varnish is drawn off through the pipe and cock *g*, and the apparatus may be immediately rinsed.

For working on a small scale boiling water may be substituted for steam. Fig. 32 represents an apparatus by means of which quite large quantities of fat copal varnish can be prepared.

Fig. 32.



A boiler, *K*, is bricked-in in a fire-place, *H*. The bottom of the boiler is bent inwards so as to offer a larger heating surface to the flame. In this boiler is placed a second boiler, *F*, the bottom of which is provided with a pipe, *A*, which is closed by a cock. The boiler *F* is provided with a lid of a peculiar shape. It consists of a strip of sheet-iron bent at a right angle, which runs around the entire edge of the boiler and forms with the latter a gutter, *R*. The cover *D* is so shaped as to fit exactly into this gutter. If the latter is filled with linseed oil and the cover placed in position, the interior of the vessel *F* is hermetically closed, but without danger from steam pressure in the interior of the vessel, because as soon as steam is developed it presses the fluid in the gutter outwards and escapes.

A projecting ring is fastened in the interior of the boiler *F* at about two-thirds of its height. Upon this ring a flat vessel, *C*, the bottom of which is perforated like a sieve, is placed. This vessel serves for the reception of the copal, previously reduced to small pieces.

For copal varnish the following quantities are used:—

Distilled copal 100 parts, volatile copal oil 20, oil of turpentine 300 to 500, linseed oil 100.

The operation begins with filling the boiler *K* with water, and heating it to the boiling-point, the linseed oil to be used being at the same time put in the boiler *F*. Next 20 parts of the copal are dissolved in the 20 parts of copal oil, and the solution added to the linseed oil. The vessel *C* is then placed in position and filled with the remaining copal. Finally, enough oil of turpentine is added to cover the copal about 4 inches deep, and then the lid is placed in the gutter filled with linseed oil.

The water in *K* is kept constantly boiling for 3 or 4 hours, the water lost by evaporation being from time to time replaced. By this process the contents in *F* acquire a sufficiently high temperature to dissolve the copal.

With the use of this apparatus there is a considerable saving in fuel and labor, as stirring is entirely done away with. No oil of turpentine is lost by evaporation, the inner space of *F* being hermetically closed by the gutter filled with linseed oil. All danger of the fluids igniting is removed, and a very light-colored and entirely clear varnish is obtained, especially when the pieces of copal are laid upon a linen cloth spread over the bottom of *C*.

When solution of the copal is complete, the finished varnish is allowed to run off by opening the cock on the discharge pipe *A*. The rarefaction of the air caused in the vessel *F* by the varnish running off would have the effect of forcing the linseed oil contained in the gutter *R* to *F* by the pressure of the outer air. The lid has, therefore, to be removed before opening the cock.

After the discharge of the finished varnish the apparatus can be immediately rinsed, and thus considerable quantities of varnish can be made in a short time.

Colorless copal varnish.—The following process yields an almost entirely colorless and durable fat copal varnish. Finely powdered East Indian copal is dried for several hours in a current of hot air, having a temperature of at least 248° F. The powder is then brought into a large glass bottle together with entirely dry powdered glass or quartz sand, and the whole mixed by shaking. Enough chloroform or petroleum-naphtha to cover the mixture is then brought into the bottle and the latter being well closed is allowed to stand quietly over night. The copal swells up during this time and can be readily dissolved in other solvents.

The next day the contents of the bottle are brought into the apparatus shown in Fig. 10, p. 104, and a suitable quantity of oil of turpentine is added. At first only a gentle heat is applied, and the apparatus is so arranged that the condensed vapors of the chloroform run back into it. After heating at 140° to 158° F. for about one hour, the solution of the copal has made considerable progress, and the cooling vessel is now so arranged that the condensed vapors of chloroform run off from the lower end of the coil. If the temperature is not allowed to rise higher than the boiling-point of the solvent used, the latter can be recovered in an entirely pure state and without much loss.

When all the solvent has been distilled off, the cooling vessel is so arranged that the vapors passing over must pass back into the apparatus, and a strong fire is kept up for about one-half to three-quarters of an hour to make the oil of turpentine boil vigorously. During this time the copal will completely dissolve in the oil of turpentine.

While the solution of copal is boiling, very pale-colored siccative linseed oil, prepared with borate of manganese, is heated in an open boiler in a water-bath to 212° F. The boiling of the turpentine is then interrupted and the solution of copal cooled off by withdrawing the fire. When it shows a temperature of from 140° to 158° F., it is gradually brought into the boiler containing the linseed oil, care being taken to stir thoroughly after each addition. After the last portion of copal solution has been added stirring should be continued for about twenty minutes. The very pale varnish is then filled into large glass bottles, where it becomes entirely clear.

Fat amber varnishes are in the main prepared in the same manner as copal varnishes. Distilled amber may be used directly with linseed oil, but the product is of a darker color than when a solution of the resin is first prepared and then mixed with a good quality of siccative oil. For a surface requiring a very durable glossy coat of varnish without much elasticity nothing is better than fat amber varnish; but where elasticity is a necessary property, copal varnish is to be preferred.

A good copal or amber varnish should leave a film on a sheet of glass which combines the qualities of hardness and toughness. The toughness is given by the oil, the hardness by the resin. Such a film should not become fissured even when it has been exposed to sunshine for a year.

Fat varnishes may also be colored, which is done in a manner similar to that mentioned later on in treating of volatile varnishes. However, they are not very frequently colored, their complete transparency being one of the principal qualities desired. Usually the article to be varnished is first stained or painted the required color and the coat of varnish is then laid on the paint.

Pale oak varnish.—Melt 4 lbs. copal, mix with 1½ gallons linseed oil 2 ozs. each of dried copperas, dried sugar of lead, and litharge. Boil the mixture well, thin with 2¾ gallons oil of turpentine, and filter.

Hard church oak varnish.—Melt 4 lbs. Kawri, mix with 1¼ gallons linseed oil, boil until it strings well, then after cooling thin with 2¼ gallons oil of turpentine. This varnish dries with a hard glossy surface in from 6 to 7 hours.

VII.

PREPARATION OF VOLATILE OR SPIRIT VARNISHES AND LACQUERS.

By volatile or spirit varnishes and lacquers are understood all those from which the solvent can be evaporated by heat without suffering decomposition. They, therefore, include all those varnishes and lacquers in the preparation of which fat oils are not used. The chief solvents formerly employed were spirits of wine and oil of turpentine, but the progress in the tar and petroleum industries has now placed at our disposal at very low prices such excellent solvents as benzole and petroleum-naphtha. The resins are now frequently dissolved in one of these solvents so that a fluid of syrupy consistence is obtained, which is reduced with spirits of wine or oil of turpentine. The cheaper wood-spirit may in many cases be substituted for spirits of wine.

Spirits of wine varnishes.—If properly prepared, these varnishes may be readily obtained as clear as water. They dry very quickly, especially in summer, and produce a smooth, glossy coating apparently faultless. But even if the varnished object be protected from all shocks, innumerable small fissures will in a short time be observed in the coat of varnish, in consequence of which it loses its lustre and even peels off. This is due to the fact that the layer of varnish consists only of the unchanged resin which lies upon the article in a thin layer. Resins being mostly very brittle substances, a very slight decrease in the temperature to which the varnished object is exposed may cause a separation of the contracting particles, whereby the above-mentioned small fissures are produced.

What has been said in regard to spirit varnishes applies to all other varnishes and lacquers in which the solvents used for their preparation do not take part in the formation of the actual layer of varnish; and the more volatile the solvent is the more rapidly the hard coating will be formed and the more readily it will crack. This defect of spirit varnishes may to some extent be remedied by using, in connection with hard resins, soft resins nearly allied to the balsams or turpentines, or by mixing the spirit varnish with an oil of turpentine varnish.

Oil of turpentine varnishes are prepared by dissolving the resins in oil of turpentine. They are not liked on account of their strong smell, which does not entirely disappear even after the lapse of considerable time, though it may be removed by heating the varnished object.

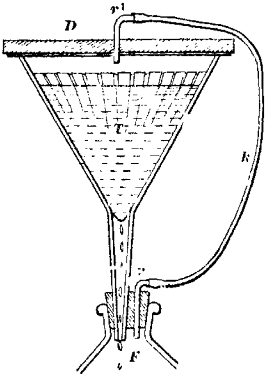
As resins can generally be more readily dissolved in oil of turpentine than in linseed oil, oil of turpentine varnishes are frequently added to fat varnishes to overcome the greater difficulty of dissolving resins in fat oils. When used by themselves, oil of turpentine varnishes produce as beautiful a coating as spirit varnishes and, moreover, possess the advantage of being less brittle. To a certain extent the oil of turpentine takes part in the formation of the layer of varnish, a very small quantity being changed into resin—becomes turpentine—and renders the coating more elastic.

Tar oil varnishes, as well as *benzole and petroleum-naphtha varnishes*, possess nearly the same properties as spirit varnishes. These solvents can be most suitably used by bringing just sufficient resin in contact with them to form a viscid fluid, and to reduce the latter with spirits of wine, oil of turpentine, etc. By this means the time required for the process is considerably shortened, the resins dissolving more rapidly in benzole and petroleum-naphtha than in alcohol. Spirits of wine, which is to be used for dissolving resins, must show at least 90 per cent., but for reducing a solution already made, a strength of 85 per cent. or even of 80 per cent. will answer. It is, however, advisable to determine first by a test how far the use of weaker spirits of wine is permissible; because if too much diluted, it has not the power of keeping all the resin in solution and a portion of the latter will separate in flakes. When in testing the varnish it is observed that it becomes less transparent, especially when exposed to a lower temperature, or commences to opalize, the spirits of wine has been too much diluted.

Preparation of volatile or spirit varnishes on a small scale.—Take a wide-mouthed bottle furnished with a well-fitting cork, the lower end of which is provided with a small hook. Tie up the resins in small bags of muslin, allowing sufficient space for swelling, and suspend the bags from the hook in the bottle filled with the solvent so that they are just immersed in it. The solution of the resins is thus accomplished without the necessity of shaking the bottle. The dissolved resin, being denser than the solvent, sinks to the bottom of the bottle, and the solvent comes constantly in contact with undissolved material.

Filtration of varnishes.—The palest and brightest varnishes are obtained by filtration. As there would be considerable loss of the volatile solvent if the filtration were carried on in open funnels, and such loss would prevent efficient filtration by the varnish becoming too thick, it is necessary to use a simple apparatus such as shown in Fig. 33. It consists of a glass jar or bottle, *F*,

Fig. 33.



which is hermetically closed by a cork with two holes. The neck of the glass funnel *T*, the upper rim of which is ground smooth, passes through one of the holes, while a glass tube, *r*, bent at a right angle, is fitted into the other. A wooden cover, *D*, with a ring of rubber on the lower side is placed upon the funnel, thus closing it air-tight.

In the center of the cover is fitted a glass tube, r', also bent at a right angle, and is connected with the tube r by the rubber hose k.

Either filtering-paper, as shown in the illustration, or fine cotton is used as filtering material. The varnish to be filtered is put in the funnel T. The lid is then placed in position, and should only be removed for the purpose of pouring more varnish into the funnel. As the varnish filters through, the air contained in the jar F is displaced and escapes through r, k, and r' into the funnel T, where it absorbs the vapor of the fluid, but absorbs nothing more after it is once saturated.

Bleaching or decoloration of varnishes.—Many varnishes for special purposes require to be absolutely colorless, and have to be submitted to a special treatment or bleaching process. Animal charcoal is generally the agent used to effect this object. It should be reduced to the fineness of coarse sand, a finer powder, though more effective, being apt to become clogged, rendering the filtering very tedious. Commercial animal charcoal contains salts that might prove injurious to the ingredients of the varnish, and hence it must be freed from them by treatment with hydrochloric acid as follows:—

Bring about 10 lbs. of raw animal charcoal into a stoneware pot having a capacity of about 5½ gallons and pour on it 5 to 8 lbs. of crude hydrochloric acid, and allow the mass to stand for one day in the covered pot, during which time it should be repeatedly stirred. Then pour the contents of the pot into a tub containing about 14 gallons of water. Allow the charcoal to settle, then pour off the supernatant fluid and again pour clean water over the charcoal, repeating the same operation until the water shows no acidity. This is ascertained by dipping blue litmus paper into the water. If the blue color is not changed, the water is free from acid; if the blue color turns red never so slightly, the water is not entirely freed from acidity. The washed animal charcoal is then dried by heat.

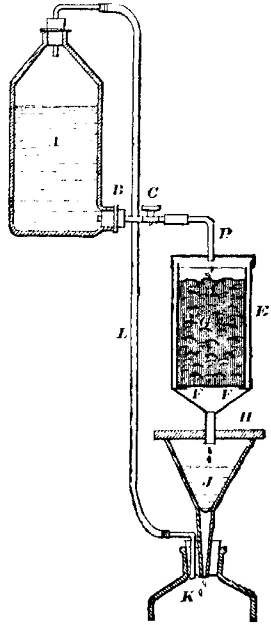
For preparing small quantities of varnish the bleaching process may be effected at the same time as filtering by placing the animal charcoal in the funnel *T*, Fig. 33, and pouring the varnish to be filtered upon it. But this operation is objectionable, as it does not permit the changing of the filtering substance or the animal charcoal, should either of them lose their efficacy. It is, therefore, preferable to carry on the operation in a special apparatus shown in Fig. 34.

The varnish to be bleached and filtered is contained in the bottle *A*. It is provided near the bottom with a neck, *B*, into which is fitted a pipe which can be closed by a cock, *C*, which is connected with the pipe *D* by a piece of rubber hose. The pipe *D*, as seen in the illustration, is fitted into the lid of the vessel *E*. This is a cylindrical sheet-iron vessel with a ring, *F*, on the bottom, which serves as a support for the cylinder *G*. This cylinder is of woven wire, and is filled with coarsely powdered animal charcoal. The tapering piece jointed to the vessel *E* enters into a pipe which passes through the cover *H* into the funnel *J*. The cover is provided with a rubber ring. The funnel is fitted into the jar *K*. A rubber hose, *L*, connects the two vessels *A* and *K*.

By opening the cock *C*, the varnish is allowed to flow into *E*, where it is bleached by the animal charcoal.

From here it passes directly into the filter and collects in *K*. The entire arrangement of the apparatus is such that, should it become necessary, the filtering material or the animal charcoal can be changed in a short time, while a loss by evaporation is at the same time prevented.

Fig. 34.



Coloring of varnishes.—The best plan is to color the varnish after the entire operation is finished. Prepare an entirely clear saturated solution of the coloring-matter in alcohol and add enough of it to the varnish to produce the desired shade. But as of some coloring-matters a considerable quantity of the solution has to be used, the varnish must be made somewhat more viscid, otherwise it would turn out too thin. With the use of aniline colors this precaution need not be observed, these colors dissolving readily and but a comparatively small quantity of them being required to produce the desired result.

Directions for preparing volatile or spirit varnishes and lacquers.—In preparing a varnish it is absolutely necessary to know for what purpose it is to be used, since a varnish intended, for instance, for coating metallic objects must possess different properties from one to be employed on leather; the first should be as glossy and hard as possible, whilst the other needs to be elastic and soft.

However, great hardness, which is always associated with a certain degree of brittleness, and, on the other hand, elasticity and pliancy, can only be obtained by the use of different kinds of resin. The hard resins, like amber, copal, and shellac, will produce varnishes possessing great lustre, which, however, are also quite brittle; whereas sandarac, mastic, elemi, and Venice turpentine possess the property of rendering varnishes more pliant and tenacious.

From what has been said above, the directions given for preparing varnishes can be readily modified in a suitable manner; should the varnish be too soft, the quantity of amber, copal, or shellac is increased; should it be too hard and brittle, this defect is remedied by an addition of soft resin, such as mastic, elemi, or Venice turpentine.

The quantity of solvent to be used for a certain quantity of varnish varies also. Viscid varnishes will be of greater value than thinly-fluid products, since the former can be reduced at pleasure. Generally 2½ parts of solvent are counted for 1 part of resin. For certain operations, for instance, bleaching and filtering, it may be necessary to reduce the varnish. To restore to it the proper degree of consistency it is allowed to run into a distilling apparatus and the necessary quantity of the solvent is distilled off.

When the business is carried on on a larger scale, it is advisable to keep a stock of dissolved resins on hand and to prepare the varnishes by simply mixing the solutions. To do this readily solutions containing the resins and solvents in a simple proportion should be prepared, and this proportion should be marked on the bottle, as, for instance:—

	Parts.
Ruby shellac	1.
90 per cent. spirits of wine	5.

By preparing such solutions on a large scale the labor of filtering may be saved, as the solid particles suspended in the fluid will in a few weeks sink to the bottom and the solution become entirely clear. Should the varnish prepared from the mixture be too thinly-fluid, it is brought to the proper consistency by evaporating in a distilling apparatus.

Amber Spirit Varnishes.

Pale amber spirit varnish.—Fused amber 8 parts, sandarac 8, mastic 2, 90 per cent. spirits of wine 48. Mix the coarsely-powdered resins with thoroughly washed coarse glass-powder and dissolve them in the spirits of wine. When solution is complete add 2 parts of Venice turpentine, mix thoroughly, and let stand until clear.

Amber spirit varnish.—Dissolve fused amber 4 parts, sandarac 6, and elemi 1, in 90 per cent. spirits of wine 12. A small quantity of camphor—about $\frac{1}{8}$ part—may eventually be added to the solution.

Amber and turpentine spirit varnish.—A rapidly-drying varnish is obtained by dissolving 20 parts of fused amber and 2 parts of Venice turpentine in 30 to 40 parts of oil of turpentine, the quantity of the latter depending on the productivity of the amber.

Amber spirit varnish for photographs.—For coating finished photographs as well as photographic negatives, a solution of amber in chloroform is very suitable. The quantities may be chosen as desired. The layer of varnish becomes in a short time so hard and solid that it can scarcely be distinguished from glass.

Amber and copal spirit varnish.—Dissolve 4 parts of fused amber and 6 of fused copal in 40 of oil of turpentine. Add to the solution, best with the assistance of heat, 2 parts of Venice turpentine.

Amber and elemi spirit varnish.—Dissolve amber 20 parts, elemi 5, and Venice turpentine 5, in oil of turpentine 60.

Copal Spirit Varnishes.

According to Heeren, copal spirit varnish is prepared as follows: Dissolve in the cold or by gentle heating 60 parts of West Indian copal in 60 parts of 98 per cent. spirits of wine, 10 parts of ether, and 40 parts of oil of turpentine. The resin dissolves readily and completely without previously swelling up. It may, however, happen that a few pieces of the resin behave differently from the rest and dissolve only to a jelly. It is, therefore, best to test the resin before dissolving it. This is readily accomplished by using only large pieces for the preparation of the varnish and separately examining small splinters of the selected pieces by gently heating them with the mixture of solvents in a test-tube. The pieces which swell up should be rejected.

Copal spirit varnish.—Melt carefully over a very moderate fire 2 parts of copal, and when the resin flows uniformly add 1 part of turpentine, and mix thoroughly with the assistance of gentle heat. Then pour the mass upon a plate and allow it to cool. It is then powdered and dissolved in 4 parts 95 per cent. spirits of wine by placing the vessel over hot water.

Pale copal spirit varnish.—Reduce 3 parts of copal to powder and pour 6 parts of acetone over it. Let the whole stand for 24 hours and then add 10 parts of 96 per cent. spirits of wine. Solution may be assisted by gentle heating over water. Then add ½ part Venice turpentine and mix thoroughly.

Copal spirit varnish with camphor.—Mix 4 parts of copal reduced to a fine powder with 1 part of pulverized camphor, and intimately triturate the mixture with 15 parts of 98 per cent. spirits of wine. Solution is assisted by heat, best by hot water.

Solution is still more readily effected by adding to the above ingredients 8 parts of oil of lavender. Pour the oil of lavender over the copal and camphor mixture, let stand overnight, and then dissolve the whole in the spirits of wine.

Copal and turpentine spirit varnish.—In its most simple form this varnish is prepared by dissolving 3 parts of copal reduced to a fine powder in 15 parts of oil of turpentine slightly heated.

Better results are, in this case, also obtained by the addition of oil of lavender, the following quantities being used: Copal 5 parts, oil of lavender 6, oil of turpentine 20.

A cheaper product is obtained by melting 4 parts of copal together with ½ part of Venice turpentine, pouring the fused mass upon a stone plate and allowing to cool. When cold it is dissolved in 8 parts of oil of turpentine.

Elastic copal spirit varnish.—Mix 4 parts of pulverized copal with 1 part of pulverized camphor, and pour 12 parts of ether over the mixture. Let the whole stand 24 hours and then dissolve in a mixture of 2 parts of oil of turpentine and 20 parts of 98 per cent. spirits of wine.

A similar varnish is prepared as follows: Dissolve camphor 5 parts and copal 20, in 60 parts of ether. The solution becomes clear only after standing a long time. It is allowed to stand for weeks in bottles, when the upper clear portion is poured off. The sediment consists of swelled-up copal, which has to be again treated with camphor 2½ to 4 parts, copal 10 parts, and ether 60 parts.

Dammar Spirit Varnishes.

These varnishes are prepared as follows: Mix coarsely comminuted dammar with equal parts by weight of oil of turpentine and heat the mixture over a moderate coal fire to gentle boiling. Then take the pot from the fire and add very gradually, with constant stirring, 1 to 1½ parts of oil of turpentine. Now heat the mixture to about the boiling-point, then take the pot from the fire and allow to cool. Filter the varnish.

The directions given above may also be modified as follows: To 3 parts of dammar melted at a very moderate heat add very gradually and in small portions ¼ part of Venice turpentine. When a homogeneous mixture has been effected, remove the pot from the fire and add very gradually oil of turpentine. The rest of the oil of turpentine—10 parts in all—is added only after the mixture is perfectly homogeneous.

In preparing dammar varnishes it is of importance that the resin should be perfectly dry. This is best effected by melting the resin, but in doing this not too strong a heat must be applied, otherwise the pale color which distinguishes dammar varnish from amber and copal varnishes is in a measure destroyed.

Dammar varnish, I.—Dammar 40 to 45 parts, oil of turpentine 50 to 60.

The preparation of this varnish requires a peculiar treatment, dammar being soluble in oil of turpentine only when the latter contains no water. If water is present, the resin is absolutely insoluble. According to an old irrational process, by which a large quantity of oil is lost by evaporation, and which besides is very dangerous on account of fire, the resin is heated in the oil of turpentine until this no longer throws up bubbles, caused by the aqueous vapor, but presents a smooth surface at a temperature of from 248° to 266° F.

A more rational process is as follows: Heat the resin, previously heated for a short time to about 225° F., with a very small quantity of oil of turpentine until the latter boils. This will form a very thick solution, which only requires to be reduced with oil of turpentine to furnish varnish.

Dammar varnish, II.—Dammar 80 parts, linseed oil 4 to 5, oil of turpentine 100.

Boil the linseed oil for a few hours with the resin and a small quantity of oil of turpentine. Though the varnish obtained in this manner is not quite as pale as that with oil of turpentine, it flows better from the brush.

Dammar and copal varnish.—Copal 40 parts, dammar 80, linseed oil 10, oil of turpentine 100.

Divide the linseed oil into two portions; dissolve the copal in one portion and the dammar in the other. Pour the solutions together and reduce with the oil of turpentine.

Elastic dammar varnish for photographs.—Dammar 4 parts by weight, acetone 18.

Bring the dammar into a bottle, pour the acetone over it, cork the bottle tightly, and let it stand in a moderately warm place for 14 days. Then pour off the solution from the residue. The varnish should be applied with a soft brush, repeating the application several times.

Mastic Varnishes.

These varnishes are usually prepared by dissolving mastic in oil of turpentine, although other volatile oils and even absolute alcohol may be employed. Mr. A. H. Church describes the process of preparing mastic varnish as follows: To prevent the resin from caking together, warm powdered glass or warm fine white quartz sand may be added to the mixture of resin and solvent. The oil of turpentine should be absolutely free from moisture; the mastic may be in tears, or preferably purified and dried. The materials are introduced into a capacious glass flask fitted with a cork, tube, and condenser so arranged that when the flask is heated in a water-bath the vapors given off from the solvent may be condensed and returned to the vessel. The temperature of the bath may be 212° F. if oil of turpentine is used; it should not be allowed to rise beyond 176° F. if absolute alcohol or 96 per cent. spirits of wine is substituted for the oil of turpentine. The following receipt gives a varnish which contains nearly 25 per cent. of its weight of mastic, but the proportion may easily be increased or decreased: Mastic 14 ounces, spirits of turpentine 44, powdered glass or fine quartz sand 6.

When the mastic has dissolved the varnish is allowed to cool, and is then poured off into a glass vessel, which is tightly closed. In this glass vessel it is allowed to rest until perfectly clear. Or it may be clarified by filtering in the apparatus described on p. 159.

The varnish prepared according to this receipt is nearly colorless, and leaves a brilliant glossy film when it evaporates on a smooth surface. But this film is very brittle, and easily abraded by gentle friction, even with the finger; in fact, it consists of little more than the original mastic resin, the fragility of which is well known. To obviate this brittleness many plans have been devised. Sometimes Venice turpentine, Canada balsam, or elemi is introduced in small quantity, not exceeding one-seventh in weight of the mastic used. In consequence of such admixture of a natural soft turpentine, the varnish produced dries more slowly, and leaves a less brittle, tougher, more adhesive, and more elastic film on evaporation. Ultimately, however, these balsams become brittle like mastic itself.

Mastic varnish, I.—Mastic 4 to 5 parts, sandarac 5 to 6, Venice turpentine ½ to ¾, spirits of wine 26 to 30.

Mastic varnish, II.—Mastic 5 to 6 parts, sandarac 10 to 12, Venice turpentine ¼ to ½, spirits of wine 26 to 30.

Mastic varnish, very transparent, for oil-paintings.—Mastic 36 parts by weight, Venice turpentine 5, camphor 1½, rectified French oil of turpentine 23, 96 per cent. alcohol 100. This varnish is prepared in a water-bath.

Held's mastic varnish for pasteboard articles.—Reduce 36 parts by weight of mastic in grains and 18 parts of sandarac to powder, and mix the powders with 20 parts of powdered glass. Then dissolve them in 200 parts of 96 per cent. spirits of wine and add 20 parts of Venice turpentine, previously liquefied, to the solution. Mix the whole by shaking and finally filter.

Common Resin Varnishes.

These varnishes are the cheapest, but also the least durable products. The simplest mode of preparing them is as follows:—

Melt, at a very moderate heat, 2 parts of very pale colophony and 1 part of Venice turpentine. When an intimate mixture has been effected take the pot from the fire and add, gradually and in small portions, 8 parts of oil of turpentine.

The following varnishes are prepared in a similar manner:—

I. Melt together colophony 2 parts, mastic 1, and Venice turpentine 3, and mix with oil of turpentine 15 parts: or,

II. Melt together colophony 8 parts, sandarac 8, and Venice turpentine 1, and mix with oil of turpentine 32 parts: or,

III. Melt together colophony 8 parts, sandarac 1, and Venice turpentine 1½, and mix with oil of turpentine 12 parts.

It may here be remarked that a simple solution of a pine resin in oil of turpentine does not furnish a useful varnish; an addition of Venice turpentine is always to be recommended, the varnish acquiring thereby somewhat greater tenacity.

However, common resin varnish does not adhere well even with the addition of Venice turpentine, and should only be used where a very cheap coating is demanded.

Flexible resin varnish.—Melt together sandarac 4 parts and colophony 2 parts. To the melted mass add gradually, as directed above, oil of turpentine 8 parts. Finally add to the solution 1 part of solution of caoutchouc in light coal-tar oil.

Asphaltum Varnishes.

For the preparation of varnishes the artificial asphaltum—tar-asphaltum—which is obtained in the distillation of tar-oils is, as previously mentioned, just as suitable as the natural product. With the use of the latter a previous remelting, similar to the roasting of copal and amber, is recommended. Tar-asphaltum does not require to be remelted. If dissolved in volatile oils and used by itself, tar-asphaltum produces varnishes of a beautiful black color and great lustre, but they are quite brittle. It is, therefore, mostly used in connection with other bodies possessing the property of decreasing this brittleness. The following directions will serve for preparing a tar-asphaltum lacquer which may be used equally well for glass, wood, leather, or metal.

Melt together 100 parts by weight of tar-asphaltum and 40 of colophony, and mix with 20 of siccative linseed oil. After a thorough mixture has been effected, add 40 parts of oil of turpentine and a small quantity of tar-oil. The varnish is ready when a sample rubbed upon a glass plate solidifies to a glossy black coating in a quarter of an hour.

If the sample should not show sufficient lustre, add some more tar-oil and mix thoroughly.

Tar-asphaltum varnish.—West Indian copal 30 parts, American pine resin 30, mineral-asphaltum 30, tar-asphaltum 30, yellow wax 6, Venice turpentine 6.

Melt the substance and make the melted mass uniform by stirring, such uniformity being attained when the mixture runs in a homogeneous thick stream from the spatula. To the melted mass, while still moderately warm, add: resin oil 12 parts, siccative linseed oil 30, oil of turpentine 30, benzole 30 to 45.

The benzole is to be added at the very last, the quantity of it depending on the object for which the varnish is to be used. If a thinly-fluid varnish is desired, more benzole has to be used. The more thinly-fluid the varnish is, the more beautiful and durable it will be. On account of its great lustre, this varnish may also be used in the manufacture of the so-called Japanese wares. It will take a beautiful gloss by being repeatedly rubbed with a flannel rag.

Double asphaltum varnish.—Mineral-asphaltum, tar-asphaltum, and American pine resin 18 parts each, siccative linseed oil, oil of turpentine, and light coal-tar oil 10 parts each, benzole 20, and lampblack 2.

The varnish is prepared as follows: First melt the mineral-asphaltum with the colophony, then add the tar-asphaltum, and when a uniform mixture has been effected, the other fluids. Finally add the linseed oil intimately rubbed together with the lampblack.

Asphaltum lacquer for leather, or military lacquer.—This beautiful lacquer for leather, which is used in the German army for lacquering straps, cartridge-boxes, etc., is prepared as follows:—

Melt together mineral-asphaltum, tar-asphaltum, and American pine resin, each 10 parts, wax 2, and paraffine 3. Add to the melted mass siccative linseed oil 40 parts, and Paris blue 2 parts. Then heat the fluid with constant stirring until it commences to give off heavy vapors From this time on samples of it must be tested. If a cooled-off sample can be drawn out into fine threads and does not show a greasy rim when dropped hot upon a piece of paper, the mass is allowed to cool off as much as possible without becoming viscid, and oil of turpentine 10 parts, and benzole 10 parts, are added to it.

Before laying on the lacquer mix 11 parts of methyl-violet in 10 parts of strong spirits of wine, and apply the mixture to the leather. When this has become dry, the lacquer is laid on.

The coat of lacquer possesses a beautiful, glossy, blue-black appearance.

Flexible asphaltum lacquer.—Dissolve 12 parts of tar-asphaltum in 6 of light coal-tar oil, which is best effected by pouring the light coal-tar oil over the comminuted asphaltum. Mix the solution with 6 parts of solution of caoutchouc in light coal-tar oil.

Black lacquer for iron.—Common asphaltum is melted in a boiler and rectified petroleum added to it with constant stirring until a cooled-off sample shows sufficient consistency to be applied with a brush. The drying of this lacquer may be much accelerated by heat. It will stand a high degree of heat, and besides it possesses a beautiful black color and the property of being elastic. For articles of iron there is no cheaper and, at the same time, better protecting varnish than this.

Asphaltum lacquer for iron.—Dissolve, with the assistance of heat, 2 parts of asphaltum in 1 part of siccative linseed oil, and dilute the solution with 3 parts of oil of turpentine.

Asphaltum lacquer for blacking bottles.—Dissolve asphaltum, 1 part, in light coal-tar oil, 2 parts, and add to the solution about 1 per cent. castor oil. This lacquer dries somewhat more slowly, but adheres more firmly to the glass.

Asphaltum lacquer may also be rendered less brittle by the addition of elemi. Melt together asphaltum, 10 parts, and elemi, 1 part, and dissolve the cold fused mass in light coal-tar oil, 12 parts.

Caoutchouc Varnishes.

These varnishes possess the exceedingly valuable property of offering a complete resistance to the influence of water, they being in this respect superior to all other varnishes, which are materially affected by that fluid. Another good quality of caoutchouc varnishes is their elasticity, so that articles coated with them will show no cracks even if standing for a long time. There are numerous solvents used for preparing these varnishes, but carbon disulphide, ether, and oil of turpentine are chiefly employed for the purpose. The oil of caoutchouc gained in the dry distillation of caoutchouc scarcely possesses greater solvent power than the oil of turpentine, but the latter is by far the cheaper. Benzole is particularly well adapted for dissolving caoutchouc and is to be preferred to carbon disulphide. The latter, though an excellent solvent for caoutchouc, evolves vapors which are positively injurious to the health of the workman. Strictly speaking, every solution of caoutchouc is already a varnish, and such solutions are particularly well adapted where a colorless coating and one which will not crack is desired. Copper-plates and maps can be very well coated with a simple solution of caoutchouc in carbon disulphide. The best method for preparing these varnishes is to allow the caoutchouc to swell up in the carbon disulphide and to effect the final solution by adding benzole and placing the vessel in warm water. The solutions should remain standing as long as possible upon the undissolved residue, to become clear; they are then carefully poured off into other bottles and stored away until they are to be used. But as the solvent is very volatile the bottles should be tightly corked, ground-glass stoppers being best for the purpose. Varnishes containing other varnish, especially copal varnish, besides caoutchouc, possess the good qualities of both varnishes, though they dry somewhat slower than the pure caoutchouc varnish. But the last-named quality may be rather an advantage, as solutions of caoutchouc in benzole or carbon disulphide dry so quickly as to require special skill to apply them in a uniform layer.

The principal reason why solutions of caoutchouc very frequently prove a failure is due to the difficulty of obtaining a material entirely free from water. Caoutchouc, on account of its impermeability to water, tenaciously retains moisture in its pores which cannot be removed even by long heating. To overcome this as much as possible it is best, before working the material, to cut it up into thin slices and dry them at from 105° F. to 122° F. for several days. The material thus prepared is less indifferent towards solvents, the solution taking place more smoothly.

Caoutchouc varnish.—Caoutchouc 1 part, carbon disulphide 10. Cut up the caoutchouc in small pieces, put them in a bottle, cover it with the carbon disulphide, and put the bottle in a moderately warm place. The caoutchouc swells up very much, but dissolves only partially, and after standing for a long time forms a clear solution over a viscous sediment. Pour off the dissolved portion very carefully.

Benzole dissolves caoutchouc better. Gradually add it in small portions to the caoutchouc until the latter is changed to a jelly; reduce the latter with light tar-oil (having a density of 0.84 to 0.85), and filter. The most complete solution is obtained by pouring benzole over the pieces of caoutchouc which have been treated with carbon disulphide and mixing the solutions together.

This varnish dries very rapidly, leaving a very thin film behind, and is, therefore, especially suitable for coating copper-plates, maps, photographs, etc. The layer of varnish, having neither color nor lustre, is invisible, and articles varnished with it can be cleansed with a moist sponge. If a tissue is dipped into this varnish or painted over with it, the stuff will be rendered water-proof, and fine cotton or silk goods treated in this manner assume a very peculiar transparent appearance. Burns covered with this varnish cease to pain, as it excludes the air and heals very rapidly.

This varnish is one of the best means of rendering articles water-proof. Matches and rockets dipped several times in this varnish may lie in water for hours without losing their inflammability.

Linseed oil and caoutchouc lacquer.—Caoutchouc 2 parts by weight, ether 1, linseed oil 2, oil of turpentine

2. Swell the caoutchouc in the ether and liquefy it by heating; then add the linseed oil and oil of turpentine (both warm), mix thoroughly, and put the fluid in a bottle to clear.

Elastic caoutchouc varnish.—Heat colophony 2 parts by weight to a point at which the mass commences to throw out vapors; then add gradually 1 part of caoutchouc, cut into small pieces. Stir the mixture constantly, and, when it has become quite homogeneous, gradually add 2 parts of hot linseed oil; then heat the whole until vapors of a disagreeable odor commence to be evolved. The vessel is then taken from the fire and stirring continued until the mass is cold.

The varnish thus obtained may be advantageously used as a water-proof coating for leather and tissues; the articles thus coated may be repeatedly bent without cracking the varnish.

The use of common petroleum for dissolving caoutchouc gives very unsatisfactory results, as only petroleum entirely free from water will dissolve it. To free the petroleum from water, mix 100 parts by weight of it with 10 parts by weight of concentrated sulphuric acid in a vessel provided with a stirring apparatus. After thorough stirring, allow the two fluids to separate by standing; then draw off the petroleum into a suitable vessel, add 3 parts by weight of litharge, and 1 part by weight of pyrolusite; throughly agitate the mixture and let it stand to clear. Petroleum thus treated is an excellent solvent for caoutchouc, and should be used especially in all cases where a quickly-drying varnish is desired.

Lacquer from hard rubber.—Old hard-rubber combs or other waste may be utilized in the preparation of lacquer which is suitable for all purposes. Melt the hard rubber in small quantities in an iron pot, stirring constantly with an iron spatula to prevent the mass from burning to the pot. When all has been melted pour the liquid mass upon a tin plate and break it into pieces after it has become cold. Put these pieces, which resemble glossy black pitch, into a bottle, and pour five to ten times their quantity of oil of turpentine over them. Instead of using oil of turpentine alone, a mixture of equal parts of it and benzole may be used, which will dissolve the rubber in a very short time. When the greater portion of the mass is dissolved, pour it off carefully from the sediment. The dark-brown lacquer thus obtained furnishes an excellent coating for metal, and when repeatedly applied gives a glossy black color resembling that of hard rubber itself.

Caoutchouc varnish for leather.—Dissolve caoutchouc 1 part by weight in oil of turpentine 8 parts by weight, and mix the solution with fat copal varnish 6 parts by weight and boiled linseed oil 4 parts by weight.

Caoutchouc varnish for gilders.—Dissolve 1 part by weight of caoutchouc in 8 parts by weight of petroleum free from water, and mix the solution with 4 parts by weight of copal varnish.

Caoutchouc varnish for glass.—Caoutchouc 1 part by weight, chloroform 60 parts by weight, mastic 10 parts by weight.

Dissolve the caoutchouc in the chloroform and then add the mastic.

This varnish, which adheres well on glass, may be colored as desired, and with it imitations of flashed glass can be prepared, and glass cemented to glass. It is also very suitable for fastening letters of glass or metal upon glass.

Gutta-percha Varnishes.

Varnishes, the essential part of which is gutta-percha, are also used for rendering tissues, paper, or leather water-proof; but for the purpose of imparting a glossy, beautifying coat to objects they are of secondary value.

The simplest form in which gutta-percha may be used for rendering tissues water-proof is as a solution in siccative linseed oil. It is also necessary to dry thoroughly the gutta-percha, which is effected in the same manner as directed for caoutchouc.

Gutta-percha varnish.—Dissolve 1 part of gutta-percha in 9 to 12 parts siccative linseed oil by heating in a water-bath, and, if necessary, strain the solution through linen.

Gutta-percha varnish for coating documents, maps, etc., so-called document lacquer.—Pour over 10 parts of thoroughly-dried gutta-percha, cut into slices, a mixture of 50 parts each of light coal-tar oil and benzine, 40 parts of carbon disulphide, and 20 parts of eucalyptus oil. Digest the mass, with occasional shaking, until the greater portion of the gutta-percha is dissolved; then let the mixture repose to clear, and pour off the clear portion. Filtering is not advisable. Should the fluid turn out too thick, reduce it with benzine to such a consistence that it can be readily applied with a brush.

The documents to be coated with this varnish should be thoroughly dried, so that they contain not even a trace of moisture. The coat of varnish applied to documents thus prepared is very durable and can be written on.

Gutta-percha varnish for leather.—This varnish, which is impervious to moisture, is prepared as follows:—

Dissolve 1 part of thoroughly-dried gutta-percha in 8 parts of siccative linseed oil in a water-bath, and mix the solution with 1 part each, of light coal-tar oil and fat copal varnish. The finished solution may be colored with mineral colors, which is best effected by triturating the colors with the copal varnish and adding the mixture to the solution.

Collodion Varnishes.

Collodion is best bought prepared, but may be readily prepared as follows: Mix 12 ozs. of sulphuric acid, 8 ozs. of nitric acid of 1.450 specific gravity, and 2 ozs. of water. The temperature of the fluid will rise to about 170° F. When it is cooled down to about 100° F. immerse perfectly dry cotton-wool, best carded and of long fibre, push it with a glass rod under the acid, and let each piece be well saturated before adding another. Cover the vessel and let it stand for 12 to 20 hours where any fumes generated may escape into the outer air; next lift the cotton out and plunge it quickly into a large quantity of water, separate the tufts with pieces of glass, and wash in several waters until no acid is left. Wring the cotton in a coarse towel as dry as possible; then pull out the tufts and place them in the air to dry.

Collodion thus made is very soluble, 5 to 6 grains of it dissolving in 1 oz. of mixed ether and alcohol.

Collodion is very suitable as a varnish for pasteboard articles, maps, etc. For use, dissolve 10 parts of collodion cotton in a mixture of 30 parts of spirits of wine and 180 parts of ether.

For photographic purposes, a solution of 1 part collodion cotton in 10 parts of absolute alcohol and 15 parts of ether is recommended.

Collodion lacquer for bottles.—Add to a solution of collodion cotton 2 or 3 per cent. of acetone or 1 per cent. of camphor. A layer of this varnish is dull and white. It is frequently colored with aniline colors, whereby peculiar effects are produced.

For the preparation of a suitable collodion solution, pure wood-spirit may be substituted for the mixture of alcohol and ether. The solution thus prepared does not differ from that obtained with ether and alcohol. If, however, the wood-spirit contains considerable quantities of acetone, as is frequently the case with the commercial article, the layer of collodion is not transparent but white, like the solution in a mixture of ether and alcohol to which camphor has been added.

Finally a peculiar product, which is brought into commerce under the name of "*amyl acetate*," is used for the preparation of a collodion varnish. Collodion cotton readily dissolves in amyl acetate to a syrupy fluid. The dry layer of collodion is colorless, clear, and perfectly transparent, and is distinguished from other collodion varnishes by greater tenacity.

Such a solution has recently been introduced in commerce under the name of "*zapon.*" It is especially recommended as a dipping lacquer for metals. It forms a colorless, transparent coat, and the metallic sheet to which it has been applied may be bent without cracking. It is so hard that it can scarcely be scratched with the finger-nail, shows no trace of stickiness, and is perfectly homogeneous on the edges. This favorable behavior is very likely due to the slow evaporation of the solvent and the fact that the lacquer quickly forms a thickish, tenacious layer, which, though moved with difficulty, is not entirely immobile. Another advantage of this lacquer—especially as regards metallic objects—is that the coating preserves the character of the basis. The coating is not sensibly affected by ordinary differences in temperature and does not become dull and opaque, as is the case with resins, in consequence of the loss of molecular coherence. It can be washed with soap and water and protects metals coated with it from the action of the atmosphere. Zapon may also be colored, but, of course, only with coloring-matters (mostly aniline colors) which are soluble in the solvent used for the collodion cotton.

Shellac Varnish.

This varnish is used more than any other spirit varnish, it being especially employed for varnishing wood (cabinet-maker's polish), for book-covers and other pasteboard and leather articles (bookbinder's and cartoon varnish), for coating the caps of bottles, and for making the so-called wash-gilding of frames (gold lacquer).

Good spirit varnishes should neither crack nor scale. These properties are obtained, on the one hand, by mixing suitable resins; and, on the other, by applying the varnish not only with the brush, but rubbing it thoroughly into the wood, as is done, for instance, by cabinet-makers in polishing with the polishing pad. A certain quantity of oil of turpentine varnish, or, still better, of fat copal varnish, may be added to such spirit varnishes as need not be absolutely colorless or to dry very quickly.

For polishing furniture, solutions of shellac in alcohol are mostly used. Dissolve 1 part of shellac in 5 or 6 parts of 90 per cent. spirit of wine without the assistance of heat. The solution is always turbid and is generally used in that state. If the layer of varnish is to be elastic, add to the solution 1 to 1½ per cent. of castor oil.

For metallic articles a shellac solution is used to which 0.3 to 0.5 per cent. of boric acid has been added.

For the preparation of a shellac solution as clear as possible, add to the solution a quantity of whiting equal to that of shellac used. Let the whole stand for at least two days, shaking it frequently. The fluid is then allowed to clear. The clear portion is finally poured off and the residue filtered.

A small addition of benzine or petroleum-ether has also been recommended for clearing shellac solution prepared with 98 per cent. spirits of wine.

Paris lacquer.—The lacquer known under this name or as *Paris wood varnish,* is an absolutely clear alcoholic solution of shellac, and is prepared as follows: Dissolve 1 part of shellac in 3 to 4 parts of 92 per cent. spirits of wine in a large flask in the water-bath, and gradually add distilled water until a curdy mass separates and the supernatant fluid appears perfectly clear. Strain the whole through a linen cloth, squeeze out the curdy mass remaining upon the cloth, and filter the combined fluids through paper. The residue may once more be stirred with 67 per cent. spirits of wine, then squeezed out, the fluid filtered and added to the first. The filtered fluid is then brought into a still, the alcohol distilled off, and the resin remaining behind dried in the water-bath until it ceases to lose weight. It is then dissolved in double its weight of 96 per cent. spirits of wine and perfumed with lavender oil.

For *light-colored* polishes bleached shellac is used. However, many sorts of shellac, in consequence of too decided bleaching, dissolve with difficulty in spirits of wine. This may be remedied by pouring sufficient ether over the comminuted shellac to cover it and letting it stand over night. After this treatment the shellac, as a rule, dissolves more readily in spirits of wine.

For *colored polishes* dragon's-blood or turmeric is used, the proportions being: Blond shellac 1 part, 96 per cent. alcohol 12, dragon's-blood or turmeric 0.2.

It is advisable to dissolve the shellac and the coloring-matter *separately* in a portion of the alcohol and to filter the solution of the coloring-matter before mixing it with the shellac solution.

Ordinary cabinet-maker's polish.—Ruby shellac 10 parts, spirits of wine 40.

This may be used for dark woods, such as walnut, mahogany, etc.

English polish.—Finest shellac 25 parts, dragon's-blood 6, 96 per cent. alcohol 75, powdered copal 6, 96 per cent. alcohol 25, finely-powdered chalk 18. Reduce the shellac and dragon's-blood to powder and dissolve them in the first-named quantity of spirits of wine. Put the copal in a second vessel, pour on the second-named quantity of spirits of wine, and add the chalk powder to it. Digest this mixture in a sand-bath for several days. When the copal has dissolved add the saturated solution of copal to the solution of shellac and dragon's-blood, mix intimately by heating, and finally filter through a cloth.

Vienna polish.—Dissolve 18 parts by weight of finest shellac in 100 parts by weight of 96 per cent. spirits of wine.

Dark-colored polish.—Dissolve 30 parts by weight of ruby shellac and 6 parts by weight of Venice turpentine in 200 parts by weight of 96 per cent. spirits of wine, and filter the solution through filtering paper.

Mahogany polish.—Bring 5 parts by weight of best shellac and 10 parts by weight of alcohol into a bottle or jar, cover its mouth with muslin or paper pierced with holes, or with a perforated cork, and effect solution by standing the vessel in a bottle of boiling water.

French polish.—Best shellac 12 parts by weight, 96 per cent. spirits of wine 150, dragon's-blood 3, and turmeric 0.05. Dissolve the powdered shellac in a glass vessel in one-half the prescribed quantity of spirits of wine by placing the vessel in a sand-bath. In a second vessel dissolve the pulverized dragon's-blood in the other half of the spirits of wine. When all is dissolved pour the two solutions together and add the turmeric. Shake well, let stand quietly for 24 hours, and filter.

White cabinet-maker's polish.—Shellac completely bleached 10 parts, spirits of wine 40 to 50.

This colorless varnish may be used for light woods, such as maple, ash, boxwood, etc., and is also employed by turners to give a beautiful glossy appearance to their work.

Moody's polish.—Shellac 4½ parts, gum benzoin 1½, dragon's-blood 3⅓, rectified wood-spirit 24.

Dissolve the ingredients in the wood-spirit by standing the vessel in a warm place or in a sand-bath, and filter the solution.

Polish for carved wood.—Digest seedlac 5 parts, transparent resin 5, in spirits of wine 45. Shake frequently until solution is effected.

For use, place the article to be polished in front of a stove, warm the polish, and apply it with a brush. To avoid brush-marks do not go over the same portion more than twice.

French polish for carved work in furniture.—Shellac 30 parts, gum arabic 7, copal 15, spirits of wine 700. Reduce the resins to a powder; sift the powder through a piece of muslin or a fine-mesh sieve; then place it in a capacious bottle, pour the spirits of wine on it, cork up the bottle, and let it stand in a moderately warm place until the resins are thoroughly dissolved, for which several days will be required. When solution is effected strain the fluid through a piece of muslin. Where large quantities of the polish are made it is advisable to use the filtering apparatus described on p. 159. For use, apply the polish with a soft hair brush to the carved portions.

Spirit varnish for woodwork.—I. Sandarac 40 parts, Venice turpentine 4, spirits of wine 120.

Dissolve the sandarac in the spirits of wine and add the Venice turpentine. Filter.

II. Sandarac 24 parts, Venice turpentine 2, mastic

16, spirits of wine 120. Dissolve the sandarac and mastic in the spirits of wine and add the Venice turpentine. Filter.

III. Sandarac 48 parts, Venice turpentine 1, mastic 24, spirits of wine 120. Prepare as above.

Pliable sandarac lac varnish for wood.—Sandarac 75 parts, elemi and animé each 25, camphor 6, 96 per cent. spirits of wine 250.

Dissolve the powdered resins in the spirits of wine and digest them in a flask by the heat of a sand-bath. Filter the solution. The product thus obtained furnishes an excellent coat of varnish.

Sandarac varnish for furniture.—Sandarac 75 parts, mastic 25, powdered glass 50, 90 per cent. spirits of wine 200, Venice turpentine 12. Mix the powdered resins with the glass and dissolve them in the spirits of wine with the assistance of heat, best by placing the flask in a sand or water-bath. Add the Venice turpentine to the solution of the resins and filter through cotton-wool.

English red furniture varnish.—Sandarac 40 parts, refined shellac 25, colophony 25, dragon's-blood 6, spirits of wine 300, Venice turpentine 4. Digest the powdered resins in the spirits of wine and then effect solution by placing the flask in a sand or water-bath. Finally add the Venice turpentine to the solution, and filter.

Dutch furniture varnish.—Sandarac 3 parts, refined shellac 1, colophony and Venice turpentine each, 2, spirits of wine 20, powdered glass 2.

Dissolve the shellac in the alcohol, filter the solution, mix the glass with the other substances previously reduced to a powder, and dissolve in the shellac solution. This is an excellent varnish.

Lacquer for basket and wicker work.—A lacquer which shall answer for this purpose must possess a certain degree of elasticity, and can be prepared without great difficulty by the following process: Boil good linseed oil in a capacious vessel until a drop of it when poured upon a cold stone slab becomes so viscid that it tenaciously adheres to the finger when touched and can be drawn out in long threads. The twentieth part of this linseed oil is mixed with good fat copal varnish, and then the lacquer is reduced with as much oil of turpentine as is required to bring it to the desired consistence. To color this lacquer, if required, it is best to dissolve an aniline color in benzole and intimately mix the solution with the lacquer.

Varnish for bamboos.—White shellac 3 parts by weight, methylated spirits 10 parts.

Dissolve and apply with a camel's-hair brush. This varnish forms a beautiful transparent coating which shows the natural color of the wood.

Basket varnish.—Orange shellac 16 ozs., yellow resin 2 ozs., benzoin 1 oz., Bismark-brown ½ oz., methylated spirit 3 pints, vegetable naphtha 1 pint.

Ebony lacquer for woodwork.—Dissolve 10 parts by weight of aniline hydrocloride in 10 parts by weight of spirits of wine. Apply the solution to the wood previously coated with a solution of 1 part blue vitriol (cupric sulphate) in 100 parts of water. This coat should be perfectly dry before applying the solution of aniline hydrochloride, which is best done with a small soft sponge. In a short time the copper salt which has been absorbed by the wood, will react on the aniline hydrocloride, producing a deep black color. This combination has been called *nigrosine*, on account of its black color, and cannot be destroyed either by acids or alkalies. The wood can, therefore, be left without further coating; but if it is desired to give it a lustre, a coating of ordinary cabinet-maker's varnish will suffice.

Lacquers for cabinet-work.—Dissolve 1 oz. of lac in 2 quarts of spirits of wine and add 8 ozs. of gluten to the solution.

Universal spirit varnish according to J. Miller.—Selected sandarac 4 parts, selected mastic 2, selected white colophony 2, camphor 1.

Pulverize the ingredients, mix them with powdered glass, and dissolve them with the assistance of heat in 24 parts of 90 per cent. spirits of wine. By observing the proportions given, and with the use of spirits of wine of proper strength, Miller claims that this varnish will answer all purposes and render any other receipt unnecessary. If greater hardness is desired, shellac is substituted for one-half of the sandarac, for instance: Bleached shellac, sandarac, mastic, white colophony, and camphor each 2 parts, 90 per cent. spirits of wine 24.

Bookbinder's varnish.—I. Elemi 4 parts, mastic 4, sandarac 6, Venice turpentine 3, spirits of wine 30.

Dissolve the resins in the spirits of wine with the assistance of gentle heat and agitation, strain, and then mix the Venice turpentine intimately with the solution.

II. Pale sandarac 6 parts, spirits of wine 40. Dissolve by cold digestion and frequent agitation.

III. Dissolve pale shellac in wood naphtha.

IV. Mastic in tears 6 parts, powdered glass (freed from the mealy portions by sifting) 3 parts, 90 per cent. spirits of wine 30 parts, oil of turpentine 3 parts.

Place the ingredients in a pot over the fire and let them boil, stirring them thoroughly. When intimately mixed, introduce the turpentine. Boil for half an hour, remove from the fire, and when cold strain through a cotton cloth.

Bookbinder's lacquer.—I. Shellac 10 parts, oil of turpentine 1, spirits of wine 30. Digest.

II. Dragon's-blood 1 part, gamboge 10, sandarac 2, shellac 20, Venice turpentine 5, spirits of wine 100.

Colorless bookbinder's lacquer.—Dissolve bleached shellac 1 part and mastic 3, in absolute alcohol 20 parts. Perfume the solution with lavender oil 0.2 part.

Bookbinder's ordinary brown lacquer.—Brown shellac 12 parts, 84 per cent. spirits of wine 175. Dissolve.

Filter the solution, evaporate or distill off one-half the alcohol, and perfume with lavender oil.

Bookbinder's white lacquer.—Dissolve bleached shellac 12 parts, in 92 per cent. alcohol 175. Filter the solution, and after reducing it one-quarter by distillation, perfume with lavender oil.

Paris-brown bookbinder's lacquer.—Shellac 25 parts, oil of lavender 1½, gamboge 3, 98 per cent. spirits of wine 125.

This lacquer is precisely prepared as the last. Add 4 parts of brown bookbinder's lacquer and finely filter from the sediment.

Bookbinder's new brown lacquer.—Refined shellac 12 parts, wood-spirit 50 parts.

Put the shellac in a glass bottle, pour the spirit over it, and frequently shake the bottle until the shellac is dissolved. Then perfume with a small quantity of oil of lavender and filter through blotting-paper.

A reddish-brown lacquer of good consistency is thus obtained, which imparts a fine lustre to articles of leather, and is very durable.

Bookbinder's new white lacquer.—Bleached shellac 18 parts, wood-spirit 50.

Put the shellac in a glass bottle and pour the wood-spirit over it. Shake frequently until solution is complete. Perfume with lavender oil, and filter the solution through blotting-paper.

Colorless varnish for bookbinders.—Mr. A. Schmidt gives the following directions for making this and several other beautiful varnishes: For 1½ lbs. good shellac take 2 ozs. crystallized carbonate of soda and ¾ gallon water. Put the whole in a clean iron or copper vessel of double the capacity, and with constant stirring bring it to boiling over a slow fire. The shellac will dissolve, and if it is intended to make *colorless French varnish*, the solution has to be run through a woollen cloth.

For *brown bookbinder's varnish*, or a colorless varnish for maps, photographs, etc., the solution has to boil about one hour longer but only simmering, and then to cool very slowly without stirring; better let it stand over night and let the fire go out under it. In the morning a wax-like substance will be found on the surface of the solution and the other impurities of the shellac on the bottom of the vessel. The solution is likewise to be run through a woollen cloth and then filtered. To make a

Transparent brown bookbinder's varnish, this filtered solution has to be precipitated with dilute sulphuric acid (1 part acid to 20 parts water), the precipitate collected on a coarse muslin cloth, and washed out with cold, clear water until it runs through without taste; then fill a stone or wooden vessel with boiling water and throw the precipitate in it; it will directly soften and stick together. This mass has to be kneaded in the hands, doubled up, melted, and drawn out till it assumes a fine silky lustre; then drawn out to the desired thickness in sticks, like candy, and it is then ready for solution. To make the bookbinder's varnish, dissolve ½ part of the precipitate in 1½ parts of 95 per cent. spirits of wine. To make the colorless varnish, dissolve ½ part of the precipitate in the same quantity of alcohol. Add 3 drachms of lavender oil to each pint. The colorless varnish will look like whey, but more transparent.

Turner's lacquer.—Elemi 2 parts, bleached shellac 10, Venice turpentine 2, spirits of wine 30.

Digest the resins in the spirits of wine.

Turner's lac varnish.—Shellac 60 parts, mastic in grains 3 parts.

Reduce the shellac and mastic to powder, pour over the mixed powders sufficient absolute alcohol to stand about 1½ inches over them, dissolve by a gentle heat, and then boil down to the consistency of syrup.

The turned articles of wood or horn are thoroughly pumiced; they next receive a coat of linseed oil, which is allowed to drain off; then a coat of the above lac varnish is applied.

Varnish for bottle caps.—Gamboge 10 parts, ruby shellac 20, Venice turpentine 5, spirits of wine 100.

Varnish for floors.—I. Colophony 10 parts, ruby shellac 20, Venice turpentine 5, spirits of wine 100. Dissolve.

II. Colophony 15 parts, ruby shellac 10, oil of turpentine 5, spirits of wine 60. Dissolve.

Bernath's lacquer for floors.—Shellac 500 parts, white colophony 250, camphor 2; 96 per cent. spirits of wine 3000.

Powder the shellac, colophony, and camphor, place the mixed powders in a bottle, and pour the alcohol over them. Put the bottle in a warm place and shake frequently until solution is complete. Filter the solution through a cloth. For use the lacquer should be warmed.

Varnish for floors according to Mommory and Raphanel.—Heat linseed oil 1 part for 16 hours and dissolve in it, 2½ parts of fused copal, and 2 parts of white colophony; then add 1 part of sandarac, 3 of bleached shellac, ½ each, of mastic and dammar. Boil the entire mass for 3 hours and then mix it with 10 parts of 90 per cent. spirits of wine.

When solution is complete, strain through a hair sieve and mix it with the desired coloring-matter. Apply the varnish to the floor with a clean brush and lay on a second coat about two hours after the first. This varnish possesses an excellent lustre and is easily cleansed with a moist sponge. Should it become dull in the course of time, rub with a rag moistened with linseed oil. This varnish may also be used for wainscoting, etc., but for such purposes 1 part of elemi should be added.

Colored varnishes with gold lustre for frame mouldings.—These varnishes may be easily prepared by adding to a thick solution of shellac a corresponding quantity of any aniline color which has been dissolved in spirits of wine; red, blue, violet, and green shades of color may be produced. After the aniline varnish has become dry, the articles receive a coat of colorless varnish.

Gold lacquer.—I. Dragon's-blood 1½ parts, gamboge 3, mastic 4, saffron 1, sandarac 4, shellac 20, spirits of wine 100.

Dissolve the dragon's-blood, gamboge, and saffron separately in small quantities of the spirits of wine and the resins in the remainder; then mix the solutions.

Gold lacquer, II.—Turmeric 5 parts, dragon's-blood 1, elemi 2, gamboge 3, seed lac 10, mastic 10, sandarac 10, Venice turpentine 5, spirits of wine 100.

Dissolve the coloring-matters separately in small quantities of the spirits of wine; filter each solution and then mix the solutions. Dissolve the resins in the remainder of spirits of wine; add the Venice turpentine and the solution of coloring-matters.

Gold lac varnish, I.—Gamboge 10 parts, mastic 25, seed lac 25, saffron 1, spirits of wine 150.

Digest the saffron in a small quantity of the spirits of wine, and also the gamboge, dissolve the resin in the remainder of the spirits of wine, and mix the solutions.

II. Turmeric 1.5 parts, dragon's-blood 20, elemi 30, gamboge 20, seed lac 20, sandarac 50, spirits of wine 50. Prepare in the same manner as the preceding.

English durable gold lac varnish.—Stick-lac 1 part, 96 per cent. spirits of wine 2 parts.

Pour the spirits of wine over the stick-lac previously reduced to a powder and effect solution by placing the vessel in a water-bath. Filter the solution through blotting-paper.

Thompson's gold lac varnish.—Gamboge, stick-lac, annotto, and dragon's-blood each, 12 parts, saffron 3, Venice turpentine 12.

Reduce the solid ingredients to powder, put each powder in a separate bottle, and pour 100 parts of spirits of wine over each. Allow to stand for fourteen days, either in the sun or a warm place, shaking frequently until all is dissolved; then add 12 parts of Venice turpentine to each solution and filter through linen. For use, pour all the solutions together or only parts of them, according as the lac varnish is desired.

Amber gold lac varnish.—Grain-lac 90 parts, yellow amber 30, gamboge 30, red sanders wood 2½, saffron 1, dragon's-blood 2, powdered glass 100, spirits of wine 600.

Reduce the solid ingredients to powder, mix the resulting powders with the powdered glass, and dissolve in the spirits of wine. Filter the solution.

Gold lac varnish which does not fade on exposure to light and air.—This varnish is claimed to be obtained by dissolving pale shellac in spirits of wine, evaporating the solution to the consistency of thin syrup, and then adding an extract of 4 parts of best French garancin in 3 parts of spirits of wine until the varnish, when spread upon a metallic surface, shows, after drying, a gold color.

Mixed gold lac varnish.—Refined sandarac 28 parts, pure pale copal 10, stick-lac 6; 96 per cent. alcohol 200, turmeric 1½, gamboge 3; 96 per cent. alcohol 25.

Reduce the sandarac, copal, and stick-lac to powder and dissolve in the alcohol by the heat of a water-bath; dissolve the powdered coloring-matters each separately in a portion of the smaller quantity of alcohol, filter the solutions, and add them to the varnish.

Varnish for gilt mouldings.—Amber 25 parts, dragon's-blood 20, gamboge 25, seed-lac 100, saffron 1, sanders wood 3, spirits of wine 500.

The varnish must stand for some time and is then to be filtered. It is best to treat the coloring-matters, the sanders wood, and the saffron by themselves and add the solutions to the varnish. A test applicable to all varnishes for gilt mouldings and gold lac varnishes can be readily made by rubbing a small quantity of varnish upon a piece of bright tin-plate. When dry a golden lustre should make its appearance. If a warmer shade of gold be required or one more inclined to reddish, a larger quantity of red coloring-matter must be used; but more yellow if a pale gold is required.

Varnish for restoring whitened German gold frames.—Reduce 30 grains of gamboge and ½ oz. of dragon's-blood to a coarse powder and add the latter to 30 grains of turmeric powder and 2½ ozs. each of shellac and sandarac. Place in a bottle with 1 pint of oil of turpentine and, keeping it in a warm place for 14 days, shake at intervals, filter, and add 4 ozs. of mastic varnish. Apply with a brush.

Dutch gold varnish.—Mastic and sandarac each, 25 parts, colophony 6, aloes 12, oil of spike lavender 40, Venice turpentine 1⅗.

Reduce the first four ingredients to powder and dissolve the powder in the spike lavender oil by placing the vessel in a water-bath; then add the Venice turpentine and filter the mixture.

If this varnish be laid on warm and very thin on polished tin, it will produce a beautiful gold color. Wood, leather, etc., upon which silver leaf has been fastened with the white of an egg, can be beautifully gilt with this varnish.

Fat gold lac varnish, I.—Dragon's-blood 1 part, gamboge 1, annotto 1, saffron 0.1, fused amber 4, grain-lac 1, linseed oil 4, and oil of turpentine 8.

Bring the first four ingredients into a glass flask and pour over them the mixture of the other ingredients. This mixture is prepared by melting together the amber, grain-lac, and linseed oil, and carefully adding the oil of turpentine. Heat the flask slowly in a water-bath until the greater portion of coloring-matters is dissolved. Filter through cotton.

II. Fused amber 2 parts, grain-lac 2, aloes 2, sandarac 1, gamboge 0.1, oil of turpentine 16.

Heat gently in a water-bath until all is nearly dissolved and finally add siccative linseed oil 1 part. Continue heating for a short time until a uniform mixture has been effected and filter through cotton.

Gold ground varnish.—Melt at a very moderate heat amber 2 parts and Syrian asphaltum ½ part, and gradually add in small portions 3 parts of siccative linseed oil. Continue heating until a uniform mixture has been effected; then take the vessel from the fire and finally add gradually 2 parts of oil of turpentine.

Varnish for preserving gilding on wood.—Boil 5 lbs. of sandarac and ½ lb. each of elemi and mastic in tears with 6 quarts of spirits of wine in a distilling apparatus for 2 hours, and after removing the fire, pour the fluid which has distilled over into the still, stirring constantly.

Red lacquer for wood.—Dragon's-blood 1 part, elemi and mastic each 2, sandarac 8, shellac 4, Venice turpentine 4, spirits of wine 50.

Dissolve the red coloring-matter in a small quantity of the spirits of wine and the other ingredients in the remainder of the spirits; then add the turpentine to the solution, next the solution of red coloring-matter, mix by agitation, and filter.

Black wood lacquer.—Elemi, seed lac, mastic, sandarac each, 1 part, shellac 2, Venice turpentine 1, spirits of wine 20, bone-black 1.

Rub up the bone-black in the turpentine and add the mixture to the solution of the resins in the spirits of wine.

French sandarac lac varnish.—I. Sandarac 75 parts, elemi 50, animé 25, camphor 7; 96 per cent. spirits of wine 190, powdered glass 50.

Dissolve the resins in the spirits of wine by means of a water-bath, adding the powdered glass to facilitate solution.

II. Sandarac 50 parts, colophony 25, refined shellac 12, Venice turpentine 30; 96 per cent. spirits of wine 200.

It is prepared in the same manner as the preceding.

Varnishes for Photographers.

Photographers require for their work a varnish which must possess peculiar properties. It must, on the one hand, be entirely colorless, adhere firmly to the glass, and be as hard as possible; and, on the other, it must be so constituted as to allow of the plate being retouched with a lead-pencil. The most important property required of these varnishes is hardness, as only in cases where the glass negative is coated with a hard varnish is it possible to take many copies without injury to the plate; and finally these varnishes must also possess a certain degree of elasticity, so as not to crack when the varnished plate is laid away, as this would be equivalent to a complete spoiling of the photographic negative. As will be seen, quite contradictory properties—hardness and elasticity—are demanded from such varnishes, and it is scarcely possible to give equal satisfaction with respect to both of them.

Varnish for photographic negatives.—Sandarac 4 parts, spirits of wine 20, chloroform $\frac{1}{2}$, oil of lavender 3.

The filtered solution is spread out by pouring it over the glass plate and dried by applying heat. The coating is entirely colorless, and negatives coated with this varnish will not crack, even if stored away for a long time.

Monkhoven's retouching varnish for negatives.—Shellac is placed for 24 hours in a saturated solution of carbonate of ammonia in water. The solution is then poured off and replaced by an equal quantity of pure water, and the fluid is boiled, with constant stirring, until solution is complete. The proportion of shellac and water should be 1 : 8. The solution is poured twice in succession over the negative, which should be thoroughly dry. Retouching can be done more rapidly and finer upon this coating than upon any other.

Retouching varnish for photographs.—Shellac 2 drachms, sandarac and mastic each, 14 drachms, ether 10 fluid drachms.

Dissolve the resins in the ether and add to the solution 10 fluid drachms of pure benzole.

Retouching varnish (*M. Janssen's formula*).—Sandarac 10 parts, camphor 2, Venice turpentine 4, oil of lavender 3, alcohol of specific gravity 0.830, 60.

This varnish may also be used for paper pictures. The retoucher should not set to work as soon as the negative has been varnished, as the film will not then be hard enough to bear the touch of a lead-pencil. The varnished film is in best condition when a day old.

Hare's colorless varnish for photographs.—Dissolve shellac by the aid of heat in 8 parts of water and 1 part of pearl-ash. Precipitate by chlorine and dissolve in alcohol.

Hard lacquer for photographic negatives.—Sandarac 40 parts, Venice turpentine 4, oil of lavender and ether each, 5, absolute alcohol 100. Digest the resins in the mixed fluids.

Photographer's lacquer, I.—Mastic 2 parts, bleached shellac 10, oil of turpentine 2, spirits of wine 60.

II. Amber 1 part, copal 1, benzole 2, spirits of wine 15.

III. Amber 2 parts, copal 2, mastic 1, petroleum-naphtha 10, spirits of wine 20.

The raw materials for preparing lacquers for photographers' use must be selected with great care, it being absolutely necessary for these lacquers to be entirely colorless.

Ferrotype varnish.—White shellac 12 parts, 95 per cent. spirits of wine 50. Add a few drops of oil of lavender to the solution.

Varnishes for Leather.

Black lacquer for leather, I.—Ruby shellac 30 parts, Venice turpentine, sandarac, and castor oil each, 1, spirits of wine 150, aniline black 5.

Rub up the aniline black in a small quantity of the spirits of wine, dissolve the resins in the remaining spirits, add the turpentine and castor oil and the solution of aniline black.

II. Shellac 10 ozs., turpentine 50 ozs., spirits of wine 400 ozs.

First dissolve 5 ozs. of extract of logwood in the spirits of wine and add to the solution one of 1 oz. of bichromate of potash. The two last-named substances impart a glossy black color to the lacquer immediately after it is dry. If a color with a greenish tinge is desired, dissolve 5 to 10 ozs. of indigo-carmine in the finished lacquer.

III. Borax 2 parts, shellac 2, water 10, logwood 2, water 2, green vitriol (ferrous sulphate) 1, water 1½.

Boil the borax and shellac in the first quantity of water, the logwood in the second quantity, and in the third dissolve the green vitriol. Mix the logwood extract and iron solution; then mix with this mixture the solution of shellac, and shake well. This lacquer has a greenish color but turns black when it is applied to leather.

Cheap glossy lacquer for leather.—Black pitch 1 part, benzole 4.

Dissolve the pitch in the benzole with the assistance of heat. The lacquer dries quickly and is very suitable for lacquering shoe leather, as it retains a certain elasticity. The latter property may be increased by adding a few per cent. of turpentine to the solution.

Lacquer for harness-makers.—Colophony 5 parts, lampblack 1, mastic 2, sandarac 5, shellac 20, Venice turpentine 5, spirits of wine 100.

Rub up the lampblack in the turpentine and mix with the solution of the resins in the spirits of wine.

Blue lacquer for leather.—According to Wiederhold this excellent lacquer is prepared as follows: Linseed oil is boiled with Paris blue, the oil thereby becoming dark brown and more thickly-fluid, with the evolution of different gases. Boiling is continued until the varnish has acquired the proper consistence, when it is allowed to cool and stand for some time, whereby a sediment is formed. The leather is painted over with the fluid portion and heated in an oven to from 86° to 100° F. By this treatment the lacquer acquires its characteristic consistence and a beautiful lustre.

The sediment separating in boiling consists of unchanged Paris blue enveloped by a resinous substance, which is soluble in oil of turpentine, and thus the Paris blue can be again used. It may also be regenerated by boiling the sediment with carbonate of soda, filtering off the liquid from the undissolved portion, washing, dissolving the undissolved portion in hydrochloric acid, and mixing both fluids.

Black leather lacquer, Valta's formula.—This lacquer, which does not crack, is prepared as follows: Melt together colophony 3 parts, sandarac 6, and turpentine 3. When all is uniformly melted, add gradually 3 parts of oil of turpentine and then allow to cool. Dissolve the cold mass together with 12 parts of shellac in 90 parts of 96 per cent. spirits of wine. Filter the solution and add 1½ parts of lampblack rubbed up with a small quantity of spirits of wine.

Lacquer for leather, H. Guenther's formula.—Add to a filtered solution of 80 parts shellac in 150 parts spirits of wine, 3 parts wax, 2 parts castor oil, and the necessary coloring-matter. Evaporate the whole to the consistence of syrup. The finished lacquer is applied to the leather by means of a brush moistened with spirits of wine or colorless spirit varnish.

Lustrous lacquer for leather, Eitner's formula.—Dissolve in a well-closed vessel 2 parts shellac in 10 parts 95 per cent. spirits of wine by placing the vessel in a warm place for about 2 or 3 days, and shaking daily; next dissolve ¼ part of dry Castile soap in 4 parts of warm spirits of wine and add ½ part of glycerin to the solution. Shake thoroughly and pour the mixture into the shellac solution. To impart to the lacquer a beautiful black color add to it a solution of ½ part of nigrosine in 1¼ parts of spirits of wine, close the vessel, shake thoroughly, and let the lacquer stand in a warm place for 14 days before using it. This lacquer is said to be especially suitable for oiled leather.

Black lacquer for leather.—Dissolve shellac 4 parts, sandarac 1 part, and mastic ½ part, in 96 per cent. spirits of wine 50 parts, and add Venice turpentine 2 or 3 parts. Color the solution intensely black with nigrosine.

Nubian blacking.—This preparation, patented in England, is, according to the specification, composed of: Shellac 36 parts, Venice turpentine 16, camphor 11, spirits of wine 126, blacking 32.

The "blacking" which constitutes the essential portion of the patent, consists of: Aniline blue 15 parts and Bismarck brown 15 parts, dissolved in spirits of wine 800 parts.

Lacquer for brown leather shoes.—Boil 4 ozs. 3 drachms of yellow wax with 8½ drachms of pearl-ash and 4 drachms of yellow soap in 13 ozs. of water until a uniform milky fluid is formed. Take the vessel from the fire and add to the liquid a solution of 0.14 drachm of phosphine in 0.91 cubic inch (15 cubic centimeters) of spirits of wine, shake until a uniform mixture is formed, and bring the mixture to 42.7 cubic inches (700 cubic centimeters) by the addition of water.

Brown lacquer for harness.—Melt yellow wax 150 parts, resin 150, and fat 120. Remove the vessel from the fire, add 150 parts of turpentine until the mixture has acquired a cream-like consistence; then add gradually 14 parts of spirits of wine and 3½ to 7 parts of caramel.

Black varnish for shoe and harness edges.—Shellac 3 ozs., resin 2 ozs., pure turpentine 1 oz., lampblack ¼ oz., 98 per cent. spirits of wine 1 pint.

Dissolve the ingredients in the spirits of wine.

Green iridescent lacquer for leather.—Reduce 8 parts of diamond fuchsine to a powder, and rub it intimately together with a solution of 25 parts of orange shellac in 100 parts of spirits of wine until a thick paste is formed. The paste should be rubbed for at least one hour, so as to divide the aniline as finely as possible. In case the paste becomes too thick during the rubbing process by the evaporation of spirits of wine, add more shellac solution. The paste is finally sufficiently reduced to allow of its being conveniently poured into a bottle. The rubbing dish is rinsed out with shellac solution to remove all the diamond fuchsine, and the fluid thus obtained added to that in the bottle. The fluid is finally diluted with sufficient spirits of wine to bring the whole to a net weight of 53 or 54 parts. Since the lacquer contains more coloring-matter than the spirits of wine can dissolve, the bottle has to be thoroughly shaken before use. By substituting for diamond fuchsine, 8 parts of methyl violet 4 B, the coating of lacquer shows a reddish lustre. Very beautiful effects are produced by the use of a mixture of 5 parts methyl violet 4 B, and 3 parts diamond fuchsine.

Varnishes for Metals.

Tar and asphaltum varnish for iron.—Melt and mix uniformly by stirring, West Indian copal 30 parts, American pine resin 30, mineral-asphaltum 30, tar-asphaltum 30, yellow wax 5, and Venice turpentine 6. Add to the melted mass, while still moderately warm, resin oil 12 parts, siccative linseed oil 30, oil of turpentine 30, and finally benzole 30 to 45. If the varnish is required more thinly-fluid, add more benzole.

Lacquer for metal.—I. A pale, hard, and at the same time, cheap lacquer for metallic articles is prepared, according to J. J. Hess, as follows: Dissolve dammar 2 parts in oil of turpentine 4, and add to the solution siccative 1 part and boiled linseed oil 2.

This lacquer is very suitable for baking on tin-plate, upon which it appears with a slightly yellowish color. By the addition of gamboge, dragon's-blood, and Syrian asphaltum, beautiful red or brown-yellow to golden tones may be given to the lacquer.

II. A lacquer of a better quality is, according to the same authority, obtained by carefully melting together: Ruby shellac 10 parts, copaiba 3, and siccative linseed oil 3. When cold, dissolve the mass in 100 to 150 parts of spirits of wine, according to the desired consistence.

III. A lacquer for metals, which is especially resistant to moisture, acid vapors, salt water, etc., is obtained by dissolving fused copal 1 part in oil of turpentine 2 to 3.

This lacquer dries very rapidly and can be ground and polished.

Lacquer for tinsmiths.—Dissolve elemi 2 parts, seed lac 10, sandarac 5, Venice turpentine 3 in spirits of wine 60.

Black varnish for tinsmiths.—Grind up fine lampblack or Frankfort black with spirits of wine and add the mixture to an alcoholic solution of shellac, or to a solution of 1 part of asphaltum digested in 3 parts of oil of turpentine, and then add some linseed oil and red lead (minium).

Lacquer for brass.—I. Seed lac 1 part, shellac 1, Venice turpentine ½, spirits of wine 20.

II. Seed lac 2 ozs., dragon's-blood 2 ozs., annotto 2 ozs., gamboge 2 ozs., saffron ½ oz., alcohol 5 pints.

Dissolve the coloring-matters separately in a small quantity of the spirits of wine, dissolve the resin in the remainder, mix the solutions, and shake well.

III. Seed lac 12 ozs., copal 4 ozs., dragon's-blood 80 grains, extract of sanders wood 50 grains, saffron 70 grains, pulverized glass ½ lb., spirits of wine 2 quarts.

Prepare in the same manner as II.

Pale lacquer for brass.—I. Methylated spirits of wine 1 gallon, sandarac 4 ozs., shellac 5 ozs., elemi 1 oz. Mix in a tin flask and expose to a gentle heat for a day or two; then strain off and add ½ gallon of spirits of wine to the sediment and treat as above.

II. Methylated spirits of wine 2 gallons, seed lac (bruised) 20 ozs., red sanders 1 oz. Dissolve and strain.

Gold-colored lacquer for brass watch-cases, etc.—Seed lac 6 ozs., amber 2 ozs., gamboge 2 ozs., extract of red sanders wood in water 24 grains, dragon's-blood 60 grains, oriental saffron 36 grains, powdered glass 4 ozs., 96 per cent. spirits of wine 36 ozs.

Reduce the seed lac, gamboge, and dragon's-blood to a fine powder and mix the latter with the powdered glass. Over this mixture pour the tincture formed by infusing the saffron and sanders wood extract in the spirits of wine for 24 hours, and strain.

Gold lacquer for metals.—Prepare a concentrated solution of picric acid in spirits of wine, and add to it alcoholic solution of pale shellac until a test shows the desired gold color; then add for every 2 lbs. of lacquer, 2½ drachms of boric acid, previously dissolved in as little spirits of wine as possible.

Gold lacquer for tin-plate.—Mix linseed oil 1 part and dark copal varnish 2 parts. Apply the lacquer with a broad soft brush to the previously cleansed tin-plate. Dry the coated plates in a drying stove. Tin-plate thus lacquered may be bent and hammered without the lacquer cracking off or losing its lustre.

Dead varnish for metals.—Sandarac 3 parts, castor oil 1, spirits of wine 20.

Dissolve the sandarac in the spirits of wine and add the castor oil.

Black (amber) varnish for metals.—Melt chips of amber in an iron vessel and the same quantity by weight of best asphaltum in a second vessel. Heat both resins to a point where they commence to evolve heavy vapors. When this is the case, add to each of the melted resins, one-half the quantity of boiling linseed oil of the resins originally used. Stir the oil thoroughly into the resins and then combine both fluids. This lacquer retains its lustre even after frequently repeated washing, and does not crack off. In varnishing articles of metal with it, it is best to heat them and to use the varnish also in a hot state, as it then can be applied in a very thin layer. Copal may be substituted for amber; but the varnish, though very good, is not so durable.

Lacquer for iron.—Ozokerite is an excellent and cheap means for protecting iron against the influence of the atmosphere. Ozokerite is a fossil wax found in bituminous shale. It forms a brown resinous mass which fuses at about 140° F. For lacquering articles of iron, melt the ozokerite in a boiler, and heat the melted mass to the boiling-point of water (212° F.). Dip the sheet-metal, previously made as bright as possible by scouring with sand, into the melted mass, allow to drain off, and ignite the ozokerite by holding the metal over a coal fire. After burning for some time, extinguish the flame, when the iron will appear with a tenaciously adhering black coating, which resists all atmospheric influences and suffers no injury from acids and alkaline bodies.

Varnish for metal workers.—Colophony 25 parts, dragon's-blood 5, gamboge 6, gutta-percha 10, shellac 3, volatile tar-oil 200.

This varnish is very useful for many purposes, it being especially suitable for all work which is to show bright metal, as, for instance, photographic objectives, microscopes, etc. The quantity of dragon's-blood may be either increased or decreased, according to whether a bronze, yellow, or brass color is desired.

Lacquer for philosophical instruments.—Gamboge 3 ozs., sandarac and elemi each, 8 ozs., best dragon's-blood 4 ozs., *terra merita* 3 ozs., oriental saffron 8 grains, seed lac 4 ozs., pulverized glass 12 ozs., 96 per cent. spirits of wine 80 ozs.

Reduce the dragon's-blood, elemi, seed lac, and gamboge to powder and mix the latter with the glass. Pour over the mixture the tincture obtained by infusing the saffron and *terra merita* in the spirits of wine for 24 hours. Strain the tincture through a piece of clean linen cloth before pouring it over the dragon's-blood, etc. If the dragon's-blood gives too high a color, the quantity may be lessened according to circumstances. The same is the case with the other coloring-matters. This lacquer has a very good effect when applied to many cast or moulded articles used in the ornamentation of furniture.

Terra merita is the root of an Indian plant; it is of a red color and is much used in dyeing. For varnish it is only employed in the form of a tincture and is particularly well adapted for the mixture of those coloring-matters which contribute most towards giving metals the color of gold. In selecting it be careful to observe that it is sound and compact.

Lacquer for steel.—Dissolve pure mastic 10 parts, camphor 5, sandarac 15, and elemi 5, in a sufficient quantity of 96 per cent. spirits of wine, and filter the solution. The lacquer is used cold; it dries clear and transparent.

Green varnish for metals.—Dissolve finely pulverized sandarac or mastic in strong potash lye until it will dissolve no more. Dilute the solution with water, and precipitate it with a solution of sulphate or acetate of copper. The green precipitate is washed, dried, and dissolved in oil of turpentine, producing a fine green varnish which does not change by exposure to light. It is especially useful for ornamental iron work.

Green transparent varnish.—Grind a small quantity of Chinese blue with double the quantity of finely powdered chromate of potash, and add a sufficient quantity of copal varnish, thinned with oil of turpentine. The tone of color may be changed by using more or less of one or the other ingredients.

Varnish for iron work.—Dissolve in 2 parts of tar-oil ½ part each of asphaltum and comminuted resin; mix hot in an iron kettle, care being taken to prevent any contact with the flame. When cold the varnish is ready for use.

Varnish for tin articles—Instead of aniline colors, which do not always yield durable colorations, metallic combinations, especially the green combinations, may be used. The process is as follows:—

Reduce 30 parts of acetate of copper to a fine powder. Bring the powder into a porcelain dish and heat at a moderate heat in a sand-bath until a pale brown powder remains behind. Mix this powder with about double the quantity by weight of oil of turpentine heated to about 167° F., and add 100 parts of a good quality of pale copal varnish. The acetate of copper, if reduced to a powder of proper fineness, dissolves almost entirely in the mixture after standing for ¼ hour. After clearing the varnish has a green color. To give tin articles a beautiful green color, four or five coats have to be applied. However, by coating the articles only twice and placing them in a hot room or upon a hot metal plate, various shades of gold color from greenish-yellow to dark yellow and orange-yellow are produced, according to the temperature to which the articles have been exposed. These gold colorations may also be produced on glass.

Black Japan ground.—I. Asphaltum 1 part, copaiba 1 lb., and a sufficient quantity of oil of turpentine.

Melt the asphaltum over a fire and mix the previously heated copaiba with it; then remove the mixture from the fire and add the oil of turpentine. Mix thoroughly.

II. Moisten a good quality of lampblack with oil of turpentine and grind it very fine with a muller on a stone plate; then add a sufficient quantity of copal varnish and rub intimately together.

III. Asphaltum 3 ozs., boiled linseed oil 4 quarts, burnt umber 8 ozs., and a sufficient quantity of oil of turpentine.

Melt the asphaltum, stir in the oil previously heated, then the umber, and, when cooling, thin down with the oil of turpentine.

IV. An extra fine black is prepared as follows: Amber 12 ozs., purified asphaltum 2 ozs., boiled linseed oil ½ pint, resin 2 ozs., oil of turpentine 16 ozs. Fuse the amber, resin, and asphaltum, add the hot oil, stir well together, and, when cooling, add the oil of turpentine.

Black Japan for tin lanterns.—Asphaltum 1½ ozs., boiled linseed oil 4 pints, burnt umber 4 ozs. Heat till well mixed, and when cool add sufficient oil of turpentine to give proper consistence.

Transparent Japan.—Oil of turpentine 16 ozs., oil of lavender 12, camphor 1 drachm, bruised copal 2.

Dissolve. This Japan is used for japanning tin.

Japan flow for tin.—I. Spirits of turpentine 3 quarts, tolu balsam 3 ozs., linseed oil ¾ pint, acetate of lead 3 ozs., balsam of fir 3 ozs., sandarac 1½ lbs.

Put the materials, except the turpentine, in a suitable vessel, place first over a slow fire, then increase the heat until all is melted. When a little cool, stir in the turpentine and strain. The japan is transparent, but may be colored if desired.

II. Melt 5 lbs. Naples asphaltum, 12 ozs. dark animé. Boil for about 2 hours in 1⅕ gallons linseed oil; then melt 1⅕ lbs. dark amber and boil it with ⅕ gallon linseed oil; add this to the other, and add driers. Boil for about two hours, or until the mass, when cooled, may be rolled into little pellets. Withdraw the heat and thin down with 3 gallons of turpentine. The mass must be continually stirred to prevent boiling over.

Varnishes for Carriages.

Ordinary body carriage varnish.—Best African copal 4 parts, clarified linseed oil 14, turpentine 16, best animé 4, clarified linseed oil 10, turpentine 14.

Two kinds of varnish have to be separately made. Boil the first three ingredients together for 4 hours, mix thoroughly by stirring, and then strain. Secondly, boil the animé, 10 parts of linseed oil, and 14 of turpentine for a similar period; strain while hot and bring into the pot used for preparing the copal varnish. Mix 2 parts of the animé varnish with 1 of copal varnish.

Neil's carriage varnish.—I. Melt 1 part best copal, add gradually 5 parts old refined linseed oil; boil until viscid; then reduce with 3 parts of oil of turpentine, and filter.

II. Melt 1 part animé, add 2½ parts linseed oil, boil for 4 or 5 hours or until viscid, reduce with 3½ parts oil of turpentine, and filter.

The varnish I. does not dry very quickly; but if this is desired, equal parts of varnishes I. and II. may be intimately mixed together by heating and constant stirring. The varnish thus obtained dries more quickly and can be polished, while the pure copal varnish is more fluid, softer, and more pliant. The first does not change its color after it has been applied, but the second becomes darker.

Dark carriage varnish.—I. Melt 50 parts best copal, add 125 parts refined linseed oil and 6 parts dried sugar of lead. Boil until viscid, and reduce with 150 parts oil of turpentine, and filter.

II. Melt 50 parts pale animé, add 100 parts of refined linseed oil and 1½ parts dried white sulphate of zinc. Boil three or four hours until viscid and reduce with 150 parts oil of turpentine. Filter.

Mix varnishes I. and II. by heating, and filter. The varnish thus obtained dries very quickly, but is not so durable as pure copal varnish.

III. Melt 50 parts best copal and add 150 parts refined linseed oil and 1½ parts litharge. Boil until viscid, and reduce with 50 parts oil of turpentine previously heated. Finally filter.

Hard drying varnish.—Melt 8 lbs. animé, mix with 2 gallons of linseed oil, boil for 4 hours, and reduce with 3½ gallons of turpentine.

VIII.

MISCELLANEOUS VARNISHES AND LACQUERS.

Brilliant lacquers.—This term is applied to shellac solutions mostly colored with aniline colors. The effect of the latter is very beautiful, and they are well adapted for the preparation of transparent lacquers; but, as previously mentioned, great care has to be exercised in their use, not all of them possessing the constancy required for lacquers. Only those soluble in alcohol can be employed. Certain aniline colors occurring in commerce are mixed with dextrin, sugar, sal ammoniac, and other substances for the purpose of increasing their weight. Such products must be especially guarded against, the added substances being, as a rule, not soluble in spirits of wine, which causes difficulties; while such as are soluble impair the quality of the lacquer and frequently spoil it entirely. If, however, mixed aniline colors can only be had, the alcoholic solution should be allowed to stand for some time and then be filtered. Before using such solution it must be tested whether it is actually clear or not, since it can only be employed when perfectly clear for coloring the shellac solutions. For light colors solutions of bleached shellac are used. The shellac should be free from any residue of the bleaching agent, especially chlorine. For dark lacquer, good blonde shellac may be employed. The lacquers are made elastic by the addition of, at the utmost, 3 per cent. castor oil. Nothing else should be used.

Aniline colors are more suitably employed in the preparation of the so-called

Resinate colors.—These colors are combinations of basic and other aniline colors, such as fuchsin, methyl-violet, brilliant green, saffranin, chrysoidin, auramin, methyl-blue, etc., with resinates. For their preparation make a resin soap solution by boiling 100 parts pale colophony, 10 parts caustic soda, 33 parts crystallized soda and 1000 parts water, and adding to the solution, when cooled to 122° F., with constant stirring, a filtered solution of coloring-matter. A solution of a metallic salt (for instance, chloride of magnesium) is then added. After some time the color combination—resinate color—separates, is then freed from the liquid portion by straining through linen, and finally dried.

The dry resinate colors have a fresh appearance; they may be prepared of various degrees of concentration with 5 to 15 per cent. coloring-matter, and are scarcely soluble in water. Weak acids or alkalies have no effect on them, but they are readily soluble in benzole, ether, chloroform, and volatile oils. They also dissolve with ease in spirit varnishes and oil of turpentine varnishes, in melting wax, resin, and boiled linseed oil. From these properties the possible practical value of these colors will be readily recognized.

They may be used in the preparation of transparent oil varnishes or benzine varnishes, the following preparation being claimed to be especially good:—

Dissolve 30 parts magnesium resinate color (thoroughly dried out) in 80 parts of benzole and 20 parts chloroform, and mix the solution with 150 parts of a clear 1.5 per cent., solution of caoutchouc in carbon disulphide and light coal-tar oil.

Lacquers prepared with resinate colors may be applied to metal, wood, paper, leather, glass, oil-cloth, linoleum, textile fabrics, etc.

Varnish for black-boards.—A varnish to be useful for this purpose should be dull, and best without lustre. A glossy surface is not good to write on, and besides a person sitting at a distance from the black-board finds it difficult to distinguish anything written on it. This evil is overcome by the following process:—

Dissolve shellac 25 parts and sandarac 7 in spirits of wine 25. At the same time dissolve, with the assistance of moderate heat, gutta-percha 3 parts in oil of turpentine 14. After the cooling of the last solution, stir both solutions together, and mix with finely rubbed emery 500 parts and lake-black 12 parts. Apply this mixture to the wood; then place the black-board in a vertical position and ignite the color on the lower edge. By this treatment the spirits of wine in the varnish is consumed, and a new coat can at once be given. Repeat this operation 5 or 6 times. By this means a surface is obtained which can be written on both with chalk and slate-pencil.

A somewhat modified process is as follows:—

Dissolve, with the assistance of moderate heat, shellac 3½ parts in spirits of wine 20 parts. Mix the solution with thoroughly rubbed emery 5 parts and best bone-black 2. The emery, as well as the bone-black, should be reduced to a fine powder, and triturated with the shellac solution until an intimate mixture has been effected. The varnish is immediately ready for use. It is applied as thinly and uniformly as possible to the black-board, ignited as described above, and the operation repeated 4 or 5 times. Any uneven places due to insufficient mixing of the ingredients are removed, when the board is cold, by rubbing with emery paper and carefully brushing over with varnish. The board thus prepared is of a fine grain, excellent black color, and without lustre.

However, burning off the layer of freshly applied varnish is a difficult operation. By the heat of the burning spirits of wine the resin melts and runs off, broad, lustrous streaks being formed thereby. The layer of varnish becomes uneven and requires much touching up.

A varnish which does not require to be burnt off is prepared as follows:—

Dissolve fused copal 20 parts, shellac 100, sandarac 50, and Venice turpentine 3, in 96 per cent. spirits of wine 400 and ether 40. Add to the solution a mixture of lampblack 15, ultramarine 5, and emery 15.

Burning off is not necessary. Should a few places turn out glossy, rub them with amber, and for the second coat increase the quantity of emery somewhat.

Universal lacquer.—Dissolve shellac 15 parts and mastic 2 in absolute spirits of wine 90. If greater consistence is required, evaporate a portion of the spirits of wine used at a moderate heat. This lacquer may be colored, as desired, with gamboge, dragon's-blood, etc.

White siccative oil.—Reduce 100 parts of acetate of lead (sugar of lead) to an extremely fine powder and mix intimately with 1200 parts poppy oil. Expose the mixture in a white glass bottle to the sunlight, shaking it frequently. The oil thus prepared is nearly colorless, and when mixed with 250 parts oil of turpentine, dries very rapidly.

Resin soap as a substitute for siccative.—Dissolve in 150 parts of water in a copper kettle 50 parts of soda, heat to boiling, and introduce with constant stirring 100 parts of powdered colophony. Continue boiling until the fluid is no longer turbid, but perfectly transparent; then take the kettle from the fire and, after cooling, pour off the supernatant fluid from the viscid brown resin soap. Dissolve the latter in water and mix the solution with a small quantity of water of ammonia. The pigments are rubbed with the mixture.

Matt lacquers for brown and black picture-frames and furniture. I. *Matt brown lacquer.*—Digest in a well-closed vessel pale grain-lac 3½ ozs., dragon's-blood ⅞ oz., and sandarac 1½ drachms in 90 per cent. spirits of wine 1 quart. Place the vessel in a warm place until all is dissolved, shaking frequently; then decant the clear solution and add a uniformly triturated mixture of 1 oz. whiting and 10½ ozs. red ochre or colcathar. Keep the lacquer in a well-closed vessel.

II. *Matt black lacquer.*—Swell 12 to 14 parts of grain-lac in 9 to 11 parts of water of ammonia; then add 70 to 80 parts of water containing 1 or 2 parts of liquid logwood extract and 0.1 part each, of cupric sulphate (blue vitriol) and acetate of lead in solution; shake thoroughly, and stir in as many parts of lampblack as are required to give sufficient blackness.

Purification of resin oils and their conversion into drying oils and varnish.—Boil the resin oil in a tinned or enamelled pot for 2 hours in the open air with 3 parts by weight of litharge, 20 of kaolin or bole, 1 of peroxide of manganese; then withdraw the fire and let stand for at least 24 hours. Stirring during heating should be avoided, the purification of the oil consisting in the carbonization of the organic substances, which does not take place if the sediment is stirred up. Draw off the oil from the sediment, filter, and press the residue. The oil thus obtained dries as well as ordinary linseed oil and does not change the shades of pigments.

The conversion into varnish or lacquer is effected as follows: To the oil obtained by the above-described process add fused amber 25 per cent., copal 25 per cent., litharge 2 per cent., peroxide of manganese 1 per cent. Bring the mixture into an autoclave and boil it under a pressure of 8 to 10 atmospheres for 6 hours. Filter when cold.

New drying oil (H. N. Busse's patent).—Old linseed oil is filtered through coarsely powdered animal charcoal in a funnel wide on top but very narrow below. The animal charcoal used in filtering is previously purified with hydrochloric acid. The filtered oil is brought into large shallow lead pans, upon the bottom of which are crystallized acetate of lead, minium, and borate of manganese. The mass is exposed to the sunlight, the pans being covered with glass plates. The lead pans are then heated to 248° F., and a current of air containing 16 per cent. steam and heated to 252° F. is conducted through the oil for 6 hours. The oil thus prepared is filled in shallow lead capsules, which are placed in rows one above the other in a large closed sheet-iron cylinder, so that there remains sufficient space for the circulation of air. In the upper portion of this cylinder is placed a wide-necked flask filled three-quarters full with chloroform, ½ lb. of the latter being required for each 12½ lbs. prepared oil. A current of air heated to 212° F. is, at the same time, allowed to act upon the upper part of the cylinder, the air passing out through a clack-valve on the bottom of the cylinder. In about 8 to 10 hours the oil is converted into a thick viscid mass, which is further treated as follows: American oil of turpentine is heated in a closed vessel to 572° F., 10 per cent. of absolute alcohol is added, and an equal quantity of the viscid mass is dissolved in this mixture at 212° F.

The at first yellowish, turbid solution is filled into cylindrical lead vessels and allowed to clear at a low temperature.

By the addition of a small quantity of this drying oil, linseed oil or oil paints acquire excellent drying properties.

Cement linseed oil varnish (E. Neumann's German patent).—The process refers to the preparation of a cheap, durable varnish, soluble in water, which is to serve as a substitute for linseed oil varnish. The process consists mainly in partially saponifying the oil and resins or solutions of both by means of an alkaline solution containing silica, then boiling, and finally entirely saponifying by the addition of ammonia. The varnish is then separated by a concentrated solution of alum and chromate of potassium in water, and, after diluting with water, is ready for use. For a more explicit explanation of the process, the mode of preparing cement linseed oil varnish is described below. Equivalent substances may, of course, be substituted for the different constituents used without any modification of the process.

For the preparation of 500 parts of varnish add 160 parts of 16 per cent. potash lye to 16 parts of Portland cement. In about 5 or 6 hours the insoluble lime combinations deposit on the bottom of the vessel, whilst the silicates in the cement pass into solution and with the potash lye form water-glass.

By this process the weight of the lye is increased about 4 per cent. It is then boiled for about 2 hours with 100 parts of linseed oil and 40 parts of Burgundy pitch, when 40 parts of 20 per cent. potash lye are added to the fluid, and boiling is continued for ½ hour longer.

By this process the greater portion of the Burgundy pitch and oil is saponified by the hot lye. To saponify the rest, about 4 parts of spirits of wine and 3.5 parts of ammonia are added with vigorous stirring. By this saponification an extremely intimate combination or mixture of the substances used is effected, so that a very homogeneous product is obtained.

Now prepare a concentrated solution of 4 parts alum and 1 part potassium bichromate in water, and add water to the solution until its at first hyacinth-red color has become chrome-yellow. Add this quite consistent fluid slowly to the previously prepared mass, and mix, with constant stirring, until a quite thick paste of a clear brown color is obtained.

To this mass add 400 parts more of the alum and potassium bichromate solution, and boil the mixture for some time, when the varnish is ready for use. By the addition of the alum and potassium bichromate solution a coagulation of the mass is, on the one hand, effected by the chromic acid; but, on the other hand, aluminium palmitate is formed from the alum and the fat or resins. This aluminium palmitate is dissolved by the ammonia present, but becomes insoluble when the varnish dries, and thus forms a durable coat.

Varnish for the preservation of wood.—Dissolve in an iron kettle borax 100 parts, caustic soda 50, in water 4000. Heat to boiling and gradually introduce, with constant stirring, shellac 450 parts. When solution is complete mix the lukewarm fluid with 200 parts of 90 or 95 per cent. carbolic acid (purified).

This varnish serves for coating wood or wooden utensils and preserves them from rotting. It is also used for painting walls upon which fungous vegetation has made its appearance. For use, make the varnish lukewarm by diluting with ⅓ its volume of hot water. This varnish may possibly serve as a substitute for carbolineum.

Tar varnish.—Heat 80 lbs. of tar in a box provided with a steam-heating pipe, or in a kettle over the fire, for some time, with constant stirring, to 158° F., in order to evaporate as much water as possible; then add, at about the same temperature, with constant stirring, 80 lbs. of hydraulic lime, Roman cement, or Portland cement. The mass gradually saponifies and, notwithstanding the large addition of cement, remains thinly-fluid. When cold it is also thinly-fluid, soft, and pliant. For use, the varnish has to be warmed. If, instead of hydraulic lime, ordinary burnt lime were added, 25 to 30 per cent. of the latter would cause the tar mass to solidify and render it unfit for varnishing purposes. By the saponification of the cement with the tar, the volatile oils of the latter are fixed and a coat of such tar varnish withstands all atmospheric influences, whilst an ordinary tar coat in time deteriorates.

This tar varnish is not attacked by hydrochloric or nitric acid, and also withstands all rotting influences. It is, therefore, very suitable for coating wood-work underground or under water. Moreover, it remains pliant after drying, so that the coat of it does not crack.

Preparation of varnish from naphtha residues.—The residues are mixed with fuming sulphuric acid and the mixture is allowed to repose for 24 hours, during which time all the impurities deposit on the bottom. The clear fluid is heated with pyrolusite (peroxide of manganese) to 437° F., neutralized with slaked lime, and filtered. The resulting product is pure mineral oil, which is brought into an autoclave provided with a steam-jacket. To every 2 lbs. of oil, 7 ozs. of oil varnish, 10 lbs. of petroleum-ether, and a small quantity of pine resin are added. The lid being placed upon the autoclave, the mixture is heated, with constant stirring, until the pressure in the autoclave rises to 2 atmospheres. The contents are then allowed to cool, when the finished varnish is drawn off. For the preparation of the oil varnish to be added, colophony or amber may be used with the addition of a small quantity of oxidizing substances. According to Mr. Berski, the originator of the process, this varnish serves as a substitute for ordinary oil varnish, but is cheaper.

Water varnish, i. e., an aqueous solution of varnish, is obtained by dissolving shellac in borax solutions. The process is as follows:—

Dissolve 1 part of borax in 20 parts of hot distilled or rain-water. To the boiling solution add gradually in small portions 3 parts of shellac, care being taken not to add a new portion before the last is dissolved. When all the shellac has been introduced allow the fluid to cool, whereby the wax-like constituents of the shellac separate. Filter the fluid from the latter and perfume the clear filtrate with a mixture of equal parts of oils of clove and turpentine, using no more of the perfume than is absolutely necessary.

Applied to leather this varnish gives it a matt lustre. The varnish may be colored as desired, water-soluble aniline colors being used for the purpose. For very pale solutions use bleached shellac.

Crystal-water varnish.—Dissolve 1 lb. of good white gum arabic and 1 lb. of glucose in 3 pints of water. This dries hard with a gloss.

Glue varnish.—Dissolve 1 lb. of good pale glue in 2 gallons of water. The color of this varnish depends on the quality of glue used. If the best gelatine be employed, a white varnish will result; if a brown glue, then a brown varnish. This varnish gives a sticky coat and is not water-proof, but may be made so by adding, just before use, a small quantity of potassium bichromate (about 1 oz. in 2 gallons). This varnish forms the basis of some leather varnishes. A little thymol or borax may be added as a preservative.

Copaiba varnish.—According to E. Friedlein, a reliable copaiba varnish may be prepared as follows: Mix copaiba with equal parts by volume of strong spirits of wine and let the mixture stand until the separated mucus has deposited. If the varnish is to be immediately used, the mixture has to be passed through filtering paper. To 50 parts of the clear solution add 5.2 parts of castor oil, which dissolves readily in the spirits of wine. These proportions have been established by experiments and should be accurately observed. In using the varnish be sure that the colors do not contain resins soluble in spirits of wine, such as sandarac, mastic, etc. Should such be the case, substitute oil of turpentine for the spirits of wine.

Varnish for tin-foil.—Dissolve 7 ozs. of shellac in 1 quart of spirits of wine and filter. Allow the mucus remaining upon the filter to drain off, it being best to cover the funnel with a glass-plate to prevent evaporation of spirits of wine. To the shellac solution thus obtained add 3½ ozs. white elemi and 14 drachms of Venice turpentine. Let the whole stand in a moderately warm place, shaking frequently; then filter, squeeze out the residue, which consists almost exclusively of elemi, and add the fluid thus obtained to the filtrate. The varnish may be colored in the same manner as brilliant lacquers.

Varnish for violins.—Dissolve sandarac 45 parts, mastic 60, elemi 15, dragon's-blood 7½ in spirits of wine 300. To the solution add oil of turpentine and castor oil, each 15 parts. Let the solution stand for 14 days and then filter.

Varnish-resisting acid (patented by Helbig, Bertling, & Reinike, of Baltimore).—The preparation of this new varnish which resists acids is effected by shaking cotton-seed oil with pure liquid lead, whereby the lead is absorbed by the oil, forming with it a metallic varnish which has no caustic properties and adheres very well.

Bring into a kettle of about 5 quarts' capacity 4½ quarts of pure cotton-seed oil. At the same time melt

20 lbs. of pure lead in a suitable crucible or ladle at 633° F. until the entire mass is liquid. In this liquid state gradually pour the lead into the 4½ quarts of cotton-seed oil, stirring constantly to effect as intimate a combination of the oil with the lead as possible. As soon as the hot liquid metal strikes the surface of the oil it is divided into small pellets, the clean and bright surfaces of which come in direct contract with the oil. When the entire 20 lbs. of melted lead have been poured into the oil, the latter is allowed to cool off and then drawn off. On the bottom of the kettle will be found about 17 lbs. of lead, the remainder, about 3 lbs., having been absorbed by the 4½ quarts of cotton-seed oil. The 17 lbs. of lead are taken from the kettle, and the oil, which now contains about 3 lbs. of lead, is returned. The 17 lbs. of lead are remelted and again poured into the oil with constant stirring, as above. The oil is again allowed to cool and then drawn off. On the bottom of the kettle will now be found about 15 lbs. of lead, so that the oil has again absorbed 2 lbs., and now contains 5 lbs. of lead in combination. The operation of remelting the remaining lead and pouring it into the oil is advantageously repeated until the oil contains about 10 lbs. of lead. Above this point the oil seems no longer to have an affinity for the metal. The oil is finally allowed to cool off, whereby it acquires the consistence of oil paint. The mixture is now ready for use, and may be applied by means of a sponge or a brush to the surfaces to be coated. It is recommended to allow the first coat to dry for about 48 hours, when it becomes sufficiently hard to withstand all ordinary abrasion. A second coat may then be applied.

Celluloid lacquers.—These lacquers can be prepared in a very simple manner by dissolving uncolored celluloid in a solvent, a mixture of strong spirits of wine and ether being very suitable for the purpose. The celluloid first swells up in the solvent, and after vigorous shaking the bottle is allowed to stand quietly for the undissolved portion to settle, when the clear, supernatant fluid is poured off. The latter may be immediately used; it yields a colorless glossy lacquer, or may be colored, as desired, with aniline colors.

The price of celluloid is at present so high that lacquers made from it are very expensive; but the lacquer may be prepared more cheaply, the process being as follows: Bring collodion-cotton, *i. e.*, soluble pyroxylin, such as is used by photographers, into a box which can be hermetically closed and place upon the bottom of the box a dish with sulphuric acid. The purpose of this is to dry the collodion-cotton, which requires from 36 to 48 hours. The collodion-cotton is then brought into a large bottle and three to four times its quantity by weight of ether and three to six times its quantity by weight of very strong alcohol poured over it. In a few days the greater portion of it is dissolved and the clear solution poured into another bottle. Add to the clear solution 25 to 30 per cent. of the weight of collodion-cotton originally used, and the resulting product forms an excellent celluloid lacquer, which rapidly hardens to a perfectly transparent and very glossy coating. For diluting celluloid lacquers it is best to use wood-spirit. To color them, dissolve an aniline color in strong spirits of wine, add a corresponding quantity of the solution to the lacquer, and shake vigorously.

Varnish for toys.—I. Melt in an iron kettle, with constant stirring, 32½ parts of yellow, transparent American resin in small pieces. When solution is complete, withdraw the fire from under the kettle and vigorously stir into the melted resin 48¾ parts of oil of turpentine. Filter the varnish through a woollen cloth and keep it in large glass bottles or barrels well closed.

II. Dissolve in a capacious barrel, without the assistance of heat, 25 lbs. of comminuted yellow, transparent American resin and 22 ozs. of Venice turpentine in 37½ lbs. of 85 or 90 per cent. spirits of wine. Stir vigorously. Filter the varnish from the residue and keep it in well-closed bottles.

Imitation Japanese lac varnish.—Free 90 parts by weight of oil of turpentine and 120 of oil of lavender from water by adding a small quantity of calcined calcium chloride, and carefully pour off the oil. Bring the oils into a bottle and add 2 parts of camphor and 30 of copal. Place the bottle in hot ashes for 24 hours, shaking it occasionally, and finally filter through a cloth. Let the filtrate stand for 24 hours and then pour off the supernatant clear fluid from the precipitate. The precipitate may be colored—black being most suitable—and used for a first covering coat. The residue from the first filtration is of no value.

Insulating varnish.—I. Shellac 1 part by weight, rectified wood-spirit 8 parts. Put the ingredients in a bottle, close the bottle with a cork, and let it stand in a warm place until the shellac is dissolved. Shake the mixture frequently. Pass the solution through a paper filter, adding from time to time rectified wood-spirit in such quantities as will enable the solution to percolat freely through the filter. Change the filter when necessary.

II. *For silk-covered wire.*—Mix boiled linseed oil 6 parts by weight and rectified oil of turpentine 2 parts.

III. *For large coils.*—Cotton-covered wires are steeped in melted, paraffine to increase their insulation. Large electro-magnet coils have a double covering of cotton, and the outer layer is coated with a thick varnish of shellac dissolved in alcohol.

Liquid bronze.—I. Stir fine metallic powder, known as bronze powder, into a varnish prepared as follows: Melt dammar with an alkaline carbonate and expose the melted, finely-powdered mass for several months to a temperature of about 122° F. The alkaline resin thus obtained is dissolved in a hydrocarbon boiling below 302° F. Any acid contained in the hydrocarbon is previously neutralized by the introduction of dry ammonia gas. The mixture of this lacquer with the bronze powder keeps for a long time.

II. Pour over 100 parts of dammar and a few pieces of glass in a bottle 900 parts of benzine. Pour off the solution from the fine sediment and glass, and suspend in it 300 to 400 parts of bronze powder. Fill in small bottles.

Soap varnish.—This varnish is elastic and impermeable. The simplest method of preparing it is as follows: Boil good tallow soap in rain-water to a clear solution and filter, while hot, through several close cloths. Add an equal volume of water to the solution, bring it to the boiling-point, and add clear boiling alum solution as long as a precipitate is formed. When the precipitate has settled, separate it from the supernatant fluid, wash it several times with boiling water, dry, and dissolve it in sufficient boiling oil of turpentine to give it the consistence of varnish. Should this prove too viscid when cold, it can be readily reduced by the addition of hot oil of turpentine. Coats of this varnish do not show a great deal of lustre, but they are durable and cheap.

Varnish for labels.—Dissolve 10 parts dammar in carbon disulphide 90. This varnish is very glossy and resists the action of both water and steam.

Dead ground for imitation gilt frames.—Bleached shellac and whiting each 8½ ozs., spirits of wine 2 quarts.

First dissolve the shellac in as small a quantity of spirits of wine as possible. Rub the solution quickly together with the whiting to a dough and gradually add the remainder of the spirits of wine. If the dry varnish shows a glossy appearance, add some spirits of wine and whiting; but if it should be too dead, add a small quantity of a thick solution of shellac.

Varnish for gilt cornices.—Shellac 42 ozs., sandarac 17½ ozs., gamboge 8¾ ozs., sanders-wood 7 ozs., turpentine 5¼ ozs., spirits of wine 5 quarts. Treat the sanders-wood by itself with a portion of the spirits of wine and add the solution to that of the resins in the remainder of the spirits of wine.

Lacquer for comb-makers.—Dissolve elemi 2 parts, mastic 2, shellac 10 in spirits of wine 40.

Varnish for copper-plates.—Dissolve camphor 2 parts, mastic 2, sandarac 5, bleached shellac 5, in spirits of wine 80.

Insoluble varnish for copper-plates and maps.—Dissolve 1¾ ozs. of good gilder's glue in 1 quart of water.

Apply the warm solution to the surface of the paper and allow to dry thoroughly; then place the paper in a solution of acetate of aluminium for one hour, wash dry, and smooth. Paper thus treated can be washed with a damp sponge.

Varnish for paste-board articles (*Held's formula*).—Reduce mastic in grains 36 parts, refined sandarac 18 parts to powder, mix the powder with powdered glass 20 parts, and dissolve in 96 per cent. alcohol 200. Add Venice turpentine 20 parts, previously liquefied, to the solution. Mix thoroughly by shaking, and filter.

Varnish for terra-cotta.—Dissolve mastic 2 parts, shellac 20, Venice turpentine 5 in spirits of wine 60.

Lacquer for gilt articles.—Dissolve amber 2 parts, dragon's-blood and gamboge each ½, seed-lac 5, sanders-wood ½, saffron 0.2 in spirits of wine 20.

Vernis d'or (*gold varnish*).—Dragon's-blood and elemi each 5 parts, gamboge 25, mastic 20, sandarac 12, shellac 20, sanders-wood 15, Venice turpentine 10, spirits of wine 600.

Dissolve each resin by itself in a portion of the spirits of wine and digest the coloring substances in another portion. Mix the solutions and filter. This varnish is very elastic, and may also be applied to leather, oil-cloth, etc. The coating will not crack, even if the articles are bent.

Gold lacquer (*mixed*).—Colophony 2 parts, gamboge, mastic, and sandarac each 5, shellac and turpentine each 2, oil of turpentine 50, spirits of wine 10.

Dissolve the colophony, gamboge, mastic, sandarac, and shellac in the spirits of wine, the turpentine in the oil of turpentine, and mix the solutions.

Gold lac varnish (*Held's formula*).—Reduce to powder shellac 60 parts, aloes 60, amber 30, sandarac 30, gamboge 8, dragon's-blood 4, and dissolve the mixed powders in oil of turpentine 500 parts by placing the vessel in a sand-bath.

To make this varnish more durable, add from 60 to 125 parts of linseed oil, allow the whole to boil up, and filter.

Varnish for sign painters.—Dissolve elemi 4 parts, mastic 5, sandarac and shellac each 10, oil of turpentine and Venice turpentine 4 in spirits of wine 100.

Glaze for barrels.—Shellac and dammar each 3½ ozs., spirits of wine 2 quarts.

Digest the resins in the spirits of wine in a well-closed bottle, shaking frequently. The glaze is ready for use when a turbid fluid has been formed. Filtering is not required. The barrels to be glazed should be entirely dry, it being best to dry and heat them by a current of hot air; then quickly apply a coat of glaze and ignite it when it has dried so far that it no longer runs. When it burns brightly, extinguish the flame by placing the lid upon the barrel, and allow to cool with the lid on. A thin layer of the glaze remains firmly adhering to the sides of the barrel and will not crack off.

Varnishes for making rubber balloons impermeable.—These varnishes are prepared from solutions of farinaceous substances, gum-tragacanth or other vegetable gum, dextrine, sugar, albumen, collodion prepared without ether, glue (isinglass, common glue). The solutions are freed from all undissolved substances by straining them through a hair-sieve, and must be perfectly clear. The main point in respect to these varnishes is that they should form an impermeable but as thin a layer as possible upon the balloon or other articles to which they may be applied. The balloon, when filled with gas, is immediately coated with the varnish for the purpose of closing the pores of the rubber and to prevent the escape of gas. Water or diluted spirits of wine is used as a solvent for the substances. Fatty substances must not be employed, as they might exert a decomposing effect upon the rubber. Only the collodion is mixed with a very small quantity of castor oil, so that the film produced upon the balloon may not be too brittle.

I. Gum 32 parts, sugar 8, water 60.

The proportions may be changed at will, according as it is desired to have the varnish more or less pliant. The varnish becomes harder if less sugar is used.

II. Dextrine 28 parts, best glue 12, water 60.

These proportions may also be varied according as the varnish is to be more or less pliant. It becomes harder the more dextrine is employed. If a very pliant varnish is desired, which, however, is not very durable, glue alone may be used by taking 60 to 70 parts of water for every 100 parts of varnish to be prepared. In regard to collodion varnish, it must contain from 5 to 6 per cent. of castor oil, but the collodion must be prepared without ether.

III. White wine 7 parts, gum-tragacanth 2, treacle 1½, spirits of wine 3.

Mix the first three ingredients and boil for 30 minutes; then allow to cool off and mix the alcohol therewith; then filter and put immediately in bottles.

Varnish for balloons made of silk and other fabrics.—I. India-rubber cut up 1 lb., oil of turpentine 6 lbs., boiled linseed oil 1 gallon.

Digest the India-rubber in the oil of turpentine in a warm place for a week, frequently shaking the vessel; then place it in a water-bath and heat gradually until solution is complete. Next add the linseed oil, previously heated, allow the whole to simmer gently for 5 minutes, with constant stirring; then cover the vessel closely, and when cool strain through flannel.

II. Bird-lime 1 lb., boiled linseed oil 3 pints, oil of turpentine as much as may be required.

Boil the bird-lime with 1 pint of the oil in an iron pot over a slow fire for about ½ hour, or until the bird-lime ceases to crackle; then add the rest of the oil, previously heated, and again boil for one hour, with constant stirring, being careful to prevent boiling over. When boiled sufficiently, which is recognized by the mass drawing threads between two knives, take the pot from the fire, allow to cool a little, add a sufficient quantity of warm oil of turpentine to reduce it to a proper consistence, and mix thoroughly.

Wax lacquer.—White wax 10 parts, benzole 15 to 18. Dissolve.

The solution reduced with petroleum or light tar-oil is very suitable as a lacquer for bright, especially white metal, and furnishes a coating which is almost invisible, but which perfectly preserves the lustre of the metal and withstands a considerable degree of heat.

IX.

MANUFACTURE OF PRINTING INK.

THE preparation of printing inks demands careful manipulation, for the presence of the smallest body in it, even if it is only a minute lump of lampblack, is sufficient to cause a stain in printing. One of the most valuable properties which printing ink should possess is durability, or the capacity to resist successfully the obliterating influence of time, and it should, at the same time, have brightness and depth of color. Printing ink should further possess the property of not drying too slowly nor too rapidly, but in proper time after it is imprinted upon paper. It must also be of sufficient consistence to prevent its penetrating so deep into the paper as to blur the appearance of printing on the other side. It must not affect the soft, elastic rollers which are employed to convey it to the types, and which, unless the ink be a perfectly innocuous preparation, are liable to considerable injury. Printing ink should not possess a strong odor, or its odor should at least volatilize in drying. When the printing is dry the ink should not run, *i. e.*, form fatty edges round the types. Finally, it should be very glossy and perfectly free from any granular appearance. If, on the extraction of a small portion from the mass, it leaves but a short thread suspended, it is considered of a good quality; but the best test of its consistence is the adhesion it shows upon pressing the finger against a quantity of it.

The most suitable material for the preparation of good printing ink is linseed oil, no substitute, under whatsoever name, possessing the same combination of good properties. Resin and soap are sometimes used as additions for the purpose of giving the ink special properties for particular purposes. For ordinary black printing ink, lampblack forms the coloring-matter. The linseed oil should be of the best quality, as an inferior article gives a bad smell and rusty color. The oil is purified by one of the methods previously described (see linseed oil), a good plan being to digest it with dilute sulphuric acid for some hours at a temperature of 212° F. The impurities are then allowed to subside and the acid is removed by repeated washing with hot water. The oil, if treated in a proper manner, should then be of a pale lemon color and entirely free from smell.

The oil is boiled at from 716° to 752° F., a temperature at which spontaneous ignition may be expected at any moment. By such boiling the oil is changed to a thick, viscid, sticky mass which leaves no grease-stain upon paper, and in combination with coloring-matters shows no yellow, fatty borders. According to the length of time the oil is boiled at this temperature, it may be more or less thickened, it being possible to prepare by long boiling a quite solid mass which does not yield to the pressure of the finger.

In the preparation of printing ink additions of any kind which accelerate the drying of the oil by oxidation must not be used, since such additions produce stickiness, which is to be avoided, and besides linseed oil boiled with preparations of lead or manganese deteriorates by keeping.

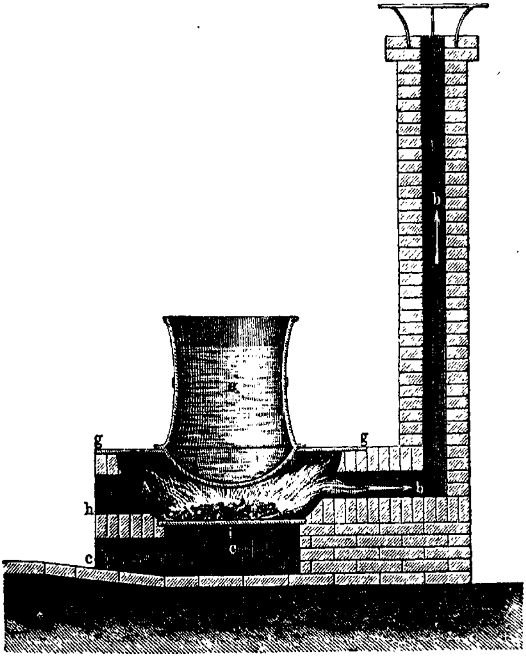
According to the desired consistence, the oil is boiled for a longer or shorter time, the ignition of the oil, which was formerly considered an absolute necessity for the preparation of a good product, being no longer practised.

The demand for cheap printing inks, especially for newspaper use, has led to the entire or partial substitution of cheaper substances, such as resin oils, resin, paraffin oil, coal-tar oil, turpentine, soap, etc., for thick boiled linseed oil. The manufacture of printing ink from such materials has been very much perfected, and such inks, which for convenience' sake may be called composition inks, are at present much used for printing newspapers. However, for printing books, etc., inks prepared from pure linseed oil are chiefly employed.

Printing ink from pure linseed oil.—For boiling the linseed oil any suitable copper or iron vessel may be used. At present, boilers greater in diameter than in depth are generally used. The size of the boiler is dependent on the quantity which is to be prepared at one time, but it is advisable to have it just large enough to allow of it being conveniently handled; hence, a capacity of 220 lbs. should only in rare cases be exceeded, and boilers which have to be lifted without mechanical contrivances should not have a greater capacity than 60 or 80 lbs. Enamelled iron is the most suitable material for the boiler; copper should be rejected on account of oxidation and consequent green coloring of the oil.

The plant shown in Fig. 35 is very convenient for boiling the oil. It consists of a brick hearth provided with a fire-place, grate, ash-pit and flue. It is covered with a cast-iron plate provided in the centre with a circular hole for the reception of the boiler. The boiler is of cast-iron, enamelled inside. It has the

Fig. 35.

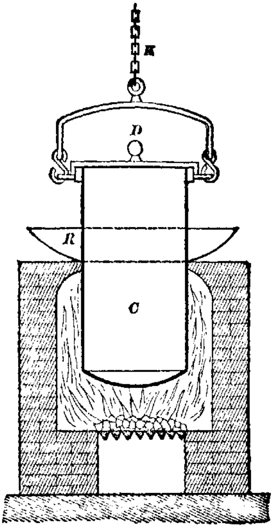


same diameter on the top and the bottom, while it is narrower in the center. The bottom is not flat, but egg-shaped. The boiler is 25½ inches deep and 17½ inches in diameter, and when filled to the top has a capacity of 110 to 130 lbs. of oil. Two wrought-iron bars, each 6½ to 10 feet long, are pushed through the handles of the boiler and serve for lifting the latter on and off the hearth. These bars are necessary, so that the persons carrying the boiler may be as great a distance as possible from it, and carry it away in case the oil should ignite. For the reception of the boiler, when not on the fire, a tripod serves, or a special iron stand provided with two, three, or four rings into which the boiler accurately fits. As may be seen from the illustration, the boiler is heated only from the bottom surface, which, however, suffices for attaining the required high temperature. As fuel, chracoal, coal, or coke may be used.

An ingenious arrangement for boiling the oil is shown in Fig. 36. It consists of a sheet-iron cylinder, *C*. The rim *R*, bent upwards like a shell, is placed about halfway up on the sides of the cylinder. The top of the cylinder is surrounded by a strong iron ring, on which are fastened the chains, *K*, of a tackle, which enables the attendants to lift the cylinder quickly from the fire. A sheet-iron head or cover, *D*, completes the apparatus, which should be erected in a fire-proof room. A flue connected with a well-drawing chimney is placed in the roof of the building to carry off the noxious vapors arising from the linseed oil. The workman should be provided with a stool high enough to enable him conveniently to take samples out of the cylinder. The chains of the tackle are secured to a movable crane, so that, at the word of command, an assistant can lift the cylinder immediately from the fire and move it aside.

Other special constructions are as follows: The boiler is placed upon a wagon running upon rails which extend into the actual fire-place. In case the oil rises too much, or there is danger of its ignition, the wagon with the boiler is pushed upon the rails from the work-room into the open air, where it is allowed to cool off.

Fig. 36.



According to another arrangement, the boiler rests in a bricked hearth, while the fuel is in a small iron wagon, which can be readily withdrawn.

The process of boiling the oil is as follows: The boiler is filled about two-thirds full with good pure old linseed oil and placed upon the hearth, a moderate fire being kept up until froth commences to form upon the oil.

The fire is then increased until the oil, at between 446° and 482° F., almost instantaneously changes its color and becomes pale greenish-yellow. It is kept at this temperature for about half an hour, when the fire is again increased. The oil now begins to throw out heavy vapors; fumes of acrolein are formed, and in about 1½ to 2 hours the oil again commences to foam. Great precaution is now required, the oil being near the temperature at which it readily ignites, and in case it foams strongly it is best to remove it from the fire. With the formation of froth, the thickening of the oil also commences, it becoming constantly thicker the longer it is kept at this high temperature. The escaping vapors become more intense, the odor of acrolein stronger, and the danger of spontaneous ignition greater.

The best plan is to keep the oil at such a temperature that the developed vapors ignite on coming in contact with a lighted candle, but will go out when the flame is removed, or can be at least easily extinguished by placing the cover upon the boiler. The firing is then regulated in such a manner that the vapors will be developed quietly and uniformly without a further rising of the oil.

If spontaneous ignition, accompanied by a slight dull report, takes place, the flame may be readily extinguished by loosely throwing, a moist, but not wet, cloth upon the oil, and covering the boiler with the lid. The lid and cloth must, however, be carefully removed and everything must be in readiness to smother the flame again; but in smothering the flame in this manner, the vapors which are constantly evolved cannot escape. This, however, can be readily overcome by the use of a wire-netting. Such a wire-netting, made in the shape of a lid and provided with a handle, immediately extinguishes the flame and at the same time permits the escape of the vapors.

The progress in the thickening of the oil is tested as follows: Take a small quantity of the oil from the boiler with a wooden spatula. Cool this sample by swinging it to and fro, and then squeeze a drop of it between the fingers and draw it out. In doing this a viscid thread, 1½ inches long before breaking, should be formed from one finger to the other. If the thread breaks before reaching that length, the boiling must be continued. If the sample is of the requisite quality, the boiler is at once lifted from the fire and the oil allowed to cool off. It was formerly the general practice to subject the oil, before cooling off, to what is technically called "burning." This consists in igniting the vapors, and allowing the oil to burn for about five minutes, when the fire is extinguished by placing the cover upon the boiler. However, as previously stated, this practice of burning has now been almost completely abandoned, as it makes the oil very dark. This is, of course, of no consequence when it is to be used for black printing ink; but it cannot be employed for colored inks, especially not for delicate shades.

By the process of boiling just noticed, the original character of the oil is totally altered. It is at first turbid, but clarifies when allowed to repose. It is now viscid and more or less adhesive; it penetrates paper with difficulty; it dries much more rapidly, and has a pyrogenous and not unpleasant odor, which soon passes off from a thin layer exposed to the air.

The consistence of the oil is dependent on the purpose for which it is to be used; the more elegant the printing is to be the more the oil must be boiled down, and the greater the expense of producing the ink will be. For newspapers, and, generally speaking, for matter which must be printed quickly, a more fluid ink is used than for printing books. The thickest ink is employed for copper-plate and lithographic printing.

On account of the quite dangerous, time-consuming, and expensive manipulation of boiling linseed oil, printing ink is now also prepared from other materials. However, the use of such inks is limited to certain branches of the printing industry. The varnishes or compositions which form the basis of such inks may be classified as follows: 1. Varnishes from boiled linseed oil and resin. 2. Varnishes from boiled linseed oil, resin, and resin oil. 3. Varnishes from crude linseed oil, resin, and resin oil. 4. Composition varnishes.

Varnish-basis from linseed oil and resin.—The basis of this varnish is the thick boiled linseed oil, the preparation of which has just been described. While the oil need not be boiled quite so long, it must be sufficiently boiled so that it does not leave a grease-stain upon paper. The resin is only used for thickening the oil, the object being the production of a material of the same consistence as that prepared by boiling linseed oil alone but considerably cheaper, since it is to be used for cheap printing ink. The linseed oil is first boiled and then allowed to clear for a short time. The resin, which should be as free from water as possible, is reduced to small pieces and melted in a pot over a moderate fire. When perfectly fluid, resin soap cut up in small pieces is added, and, when this is dissolved, the boiled linseed oil also. The whole is then thoroughly stirred, allowed to stand upon the fire for half an hour until quite thinly-fluid, and then filtered through fine linen to separate admixed impurities of the resin. The oil is then allowed to repose in as hot a state as possible, so that dust-like impurities which would not settle from a thick mass may deposit on the bottom. After reposing for a few days the oil is decanted or drawn off.

The proportions given below may be changed as required. A larger addition of boiled linseed oil always improves the quality of the printing ink, it becoming thereby more pliant and viscid, and prints better.

FORMULA I.

	Parts by weight.		
	Weak	Medium.	Strong.
Resin	12½	12½	12½
Boiled linseed oil	50	50	50
Resin soap	1½	1½	1½
Linseed oil very slightly boiled	3½	2	—

FORMULA II.

	Parts by weight.		
	Weak	Medium.	Strong.
Resin	25	25	25
Boiled linseed oil	50	50	50
Resin soap	5	5	5
Linseed oil very slightly boiled	4½	3	—

FORMULA III.

	Parts by weight.		
	Weak.	Medium.	Strong.
Resin	38½	38½	38½
Boiled linseed oil	50	50	50
Resin soap	3½	3½	3½
Linseed oil very slightly boiled	6	4½	—

Varnish-basis from resin oil.—The use of resin oil for the manufacture of printing inks was proposed as early as 1848 by Pratt, of New York, his formula being as follows: Resin oil 10 parts by weight, resin 4, yellow soap 1. Solution to be effected with the assistance of heat. If greater consistence was required, the quantities of resin and soap were to be increased, and to be decreased for a more thinly-fluid ink. A later formula was as follows: Resin oil 50 parts by weight, resin 39, white soap 9. The ingredients were to be heated, with constant stirring, until a homogeneous mixture had been effected. To give the oil greater consistence, the quantities of resin and soap were to be increased, and to be decreased to render the oil more thinly-fluid.

However, the extensive use of resin oil for the manufacture of printing ink dates from 1860, when, in consequence of the general progress in the resin industry, it became possible to produce an oil of a less penetrating odor than formerly. Printing inks for newspapers are at the present time almost exclusively prepared with resin oil, though the readers complain frequently enough about the bad smell.

The resin and resin oil are together heated in a boiler, the soap is then added, and finally the boiled linseed oil. The whole is then kept at a temperature of from 248° to 284° F. for a few hours, to evaporate, as much as possible, the smell of the resin oil and to effect an intimate mixture of the ingredients.

1. *Weak Varnish-basis with Boiled Linseed Oil.*

a. Linseed oil very slightly boiled 7 parts by weight, resin soap 3, boiled linseed oil 50, resin oil 50, resin 25.

b. Linseed oil very slightly boiled 9 parts by weight, resin soap 5, boiled linseed oil 50, resin oil 50, resin 50.

c. Linseed oil very slightly boiled 12 parts by weight, resin soap 7, boiled linseed oil 50, resin 75, resin oil 50.

2. *Medium Strong Varnish-basis with Boiled Linseed Oil.*

a. Linseed oil very slightly boiled 4 parts by weight, resin soap 3, boiled linseed oil 50, resin oil 50, resin 25.

b. Linseed oil very slightly boiled 6 parts by weight, resin soap 5, boiled linseed oil 50, resin oil 50, resin 50.

c. Linseed oil very slightly boiled 9 parts by weight, resin soap 7, boiled linseed oil 50, resin oil 50, resin 50.

3. *Strong Varnish-basis with Boiled Linseed Oil.*

a. Resin soap 3 part by weight, boiled linseed oil 50, resin oil 50, resin 25.

b. Resin soap 5 parts by weight, boiled linseed oil 50, resin oil 50, resin 50.

c. Resin soap 7 parts by weight, boiled linseed oil 50, resin oil 50, resin 75.

4. *Weak Varnish-basis with Crude Linseed Oil.*

a. Thick turpentine 0.5 part by weight, resin soap 0.5, boiled linseed oil 13, resin oil 24, crude linseed oil 21.

b. Resin soap 0.7 part by weight, linseed oil 3.5, resin oil 9.5, resin 10.

5. *Medium Strong Varnish-basis with Crude Linseed Oil.*

a. Resin soap 0.5 part by weight, thick turpentine 0.5, boiled linseed oil 105, resin oil 24, crude linseed oil 21.

b. Resin soap 0.7 part by weight, linseed oil 350, resin oil 8, resin 10.

6. *Strong Varnish-basis with Crude Linseed Oil.*

a. Resin soap 0.5 part by weight, thick turpentine 0.5, boiled linseed oil 8.7, resin oil, crude linseed oil 21.

b. Resin soap 0.7 part by weight, linseed oil 2.5, resin oil 8, resin 10.

Composition Varnish-basis.

a. For editions de luxe.—I. Copaiba 70 parts by weight, ordinary linseed oil 50, colophony 110, amygdaloid benzoin 3, tolu balsam 2, or

II. Copaiba 85 parts by weight, ordinary linseed oil 40, colophony 115, amygdaloid benzoin 3, tolu balsam 2.

b. According to Goyneau.—I. Linseed oil 979 parts by weight, resin 735, treacle 245, litharge 125.

II. Linseed oil 400 parts by weight, resin 980, treacle 490, litharge 60.

III. Linseed oil 980 parts by weight, resin 958, treacle 980, litharge 122.

The oil is mixed with the litharge and heated over a moderate fire to ebullition and until the froth begins to subside, when the colophony previously melted with a small quantity of linseed oil is added. The whole is then thoroughly stirred and allowed to cool off somewhat, when the treacle is added.

c. According to Savage.—Dissolve together copaiba 32 parts by weight and resin soap 12.

d. According to Knecht.—Dissolve in a water-bath Venice turpentine 5 parts by weight, castor oil 15, and white wax 1, and mix thoroughly.

e. According to Roesl.—Mix, with the assistance of heat, thick turpentine 9 parts by weight, soft soap 10, and oleic acid 4.

f. Resin soap varnish for printing in gold.—This composition consists of a solution of resin soap with an addition of glue and glycerin. It is prepared as follows: Dissolve in 150 parts by weight of water in a copper kettle 50 parts of soda and gradually introduce, with constant stirring, 100 parts of colophony and boil for 2 or 3 hours, until the fluid is no longer turbid but perfectly transparent; then, after cooling, pour off the fluid from the viscid, brown-colored resin soap on the bottom of the boiler, add to the latter 100 parts of water and 15 parts of glue previously swelled, and heat until all is dissolved. The varnish thus obtained dries very rapidly; if it is to dry more slowly, add from 10 to 20 parts of glycerin of 28° B.

g. According to Thenius.—Boil 25 parts by weight of linseed oil and 3 parts of fine litharge until a sample of the oil becomes thick on cooling; then remove the boiler from the fire and let it stand quietly. In another pot melt 10 parts by weight of pale American colophony, add the melted mass to the thick boiled linseed oil, heat for some time, and then stir until cold. The mixture should be thickly-fluid and of the consistence of honey.

Having described the various varnishes or compositions which form the basis of printing inks, it only remains to give an account of the

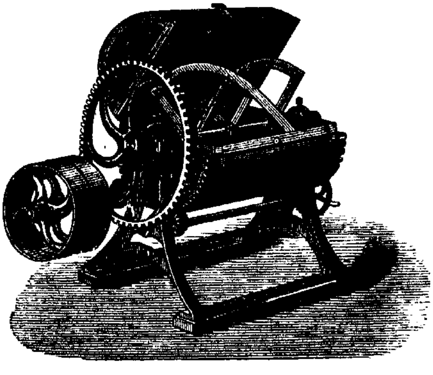
Manufacture of printing inks.—Ordinary black printing ink consists of one of the varnishes or compositions previously described and lampblack. The materials used in the manufacture of lampblack are very varied and comprise all kinds of oils, fats, coal-tar oil, and greases; in fact, anything that will yield a great deal of black smoke while burning, preference being given to those which are cheapest and least available for any other purpose. There are some differences in the quality of the blacks yielded by the different kinds of material used; the fat oils and greases yield the best blacks, the hue being better and the black finer and less greasy than from any other kind of grease. The greases from coal-tar give fair blacks; they are rather browner in hue than the blacks from the fat oils and more inclined to be oily from some of the material volatilizing at the high temperature at which it is burnt. The residues from the distillation of shales give fair blacks, but are liable to contain traces of volatile, unburnt matter.

The process of manufacture of lampblacks consists essentially in burning the material and collecting the soot. The plant used for the purpose varies according to the material to be burnt, but consists essentially of two parts, a lamp or furnace in which the material is burnt and chambers in which the black collects.

Lampblack forms a black flocculent powder with a fine texture. In color it is usually what is termed a jet-black, although some samples have a faint brownish tinge. It has great coloring and covering powers. It is rather difficult to mix with various articles, especially with water. It consists almost entirely of carbon, but there is a small quantity of moisture and mineral matter present in all varieties. Good lampblack should produce a fine mass which can be readily rubbed together with fat oil, and should be of a pure black color. Lampblack prepared at too low a temperature has mostly a brownish shade of color, while that which has been heated too much has a dull black color and is granular, which renders it more difficult to mix with the varnish.

The mixing of the varnish with the lampblack is best effected in a mixing mill. Fig. 37 shows a mixing mill for printing inks, manufactured by J. M. Lehmann, of Dresden, Saxony. The mill consists of a strong iron frame in which rests a cylindrical trough which can be revolved around its axis. In the trough itself is the actual mixing contrivance in the form of segmental

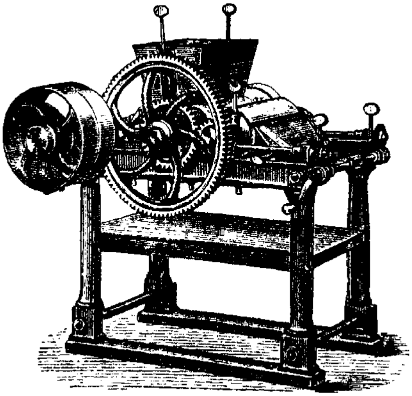
Fig. 37.



paddles, which, in connection with the revolving motion of the trough, effect a thorough mixing of the varnish and the lampblack. The *pulp*, as the product coming from the mixing mill is called, is next very carefully ground by being passed between hard stones of a very fine texture driven by heavy machinery, the motive power being steam.

Fig. 38 shows a mill for grinding the pulp, which is also manufactured by J. M. Lehmann, of Dresden. It is furnished with three very finely polished porphyry rolls, which are harder than steel. The pulp adheres well to the rolls, in consequence of which it is ground as finely as possible. With proper treatment of the mill, the pulp cannot protrude over the edges of the rolls. The rolls run at an unequal speed, the front one having besides a lateral motion. Another advantage of the

Fig. 38.



mill is that the rolls, in consequence of their peculiar construction and the properties of the porphyry, run off entirely clean when the work is finished, so that the mill is also available for small quantities. The material to be ground is brought between the first and second rolls, by which it is transferred to the third, from which it is scraped off and falls into vessels placed under the mill.

The proportion between lampblack and varnish varies, but depends chiefly on the quality and origin of the former, though, generally speaking, for 100 parts of varnish from 20 to 40 parts of lampblack will be required.

Fine printing inks, especially those used for illustrations and *editions de luxe*, should show a certain blue-black color and lustre, which cannot be produced with lampblack alone. For this purpose Paris blue or indigo is added, though aniline colors have also been successfully used. Paris blue and indigo being hard to grind, it is best to subject them to a preparatory process, which consists in soaking them in 96 per cent. alcohol for one or two days, then pulverizing them and finally evaporating the alcohol by exposing the powder to the air. The aniline colors to be used, especially blue and violet, must be soluble in fat, and dissolved in the varnish, so that not even a minute lump remains undissolved.

The quantity of lampblack, as previously stated, being chiefly dependent on its quality, the directions given below for the composition of printing inks are not to be taken as absolutely correct under all circumstances, they being subject, under certain conditions, to many modifications.

Printing Inks for Revolving Presses.

	Parts by weight		
	Weak.	Medium.	Strong.
1. Varnish	70	72	72
Lampblack	30	28	28
2. Varnish	72	74	74
Lampblack	28	26	26

Printing Inks for Steam Presses.

a. Printing ink for newspapers.—Varnish 78 parts by weight, lampblack 22; *or,*

Varnish 76 parts by weight, lampblack 24.

b. Printing ink for book-work.—Varnish 77 parts by weight, lampblack 23; *or,*

Varnish 79 parts by weight, lampblack 21; *or,*

Varnish 80 parts by weight, lampblack 20.

c. Printing ink for illustrations.—Varnish 78 parts by weight, lampblack 20, Paris blue 2; *or,*.

Varnish 78 parts by weight, Paris blue 2, indigo 1, lampblack 19; *or,*

Varnish 78 parts by weight, Paris blue 1, *bleu d'acier* 2, lampblack 19.

Since the same varnish forms the basis of all the printing inks given above, it will be readily understood that their beauty and selling value depend almost entirely on the quality of the lampblack. It is impossible to incorporate in a printing ink anything better than a good quality of oil varnish, and hence all printing inks would be of the same quality if there were not a difference in the fineness of the lampblacks. For medium-priced newspaper printing inks, ordinary lampblack from tar and paraffin oils or resin may, therefore, be used; while for printing inks for book-work and illustrations the better qualities have to be employed. For this reason it is difficult to give definite formulæ for separate printing inks, and the receipts given are simply intended as a sketch of the proportions ordinarily used.

Colored printing inks.—For the preparation of colored printing inks the coloring-matter is mixed and ground with the varnish in the same manner as described for black printing ink. The varnish used for the purpose should be of as light a color as possible, especially for delicate shades.

Indigo gives a deep but dull *blue;* it is cold but permanent. *Paris blue* needs much grinding; it affords a deep, bright color, and is useful for making greens. *Antwerp blue* is easily ground to the proper degree of fineness, makes a good ink, and works clean and well; its tint is bright and light, with a slight green tendency.

Various shades of *green* may be produced by suitable admixture of blues and yellows. Prussian blue and chromate of lead make a good, rich green; indigo and the same yellow, a deeper, duller color; Antwerp blue and the same yellow, a brilliant, rich green. The chromate must be quite pure to insure good colors.

For *red, carmine* may be readily ground into a fine ink of brilliant color by admixture with black ink varnish made with balsam of copaiba. It is rather expensive but valuable for special purposes. *Crimson lake* is readily reduced by the muller. It works clean, but does not possess much depth. A deeper tone than that obtained from commercial lake may be produced as follows: Boil 1 oz. of the best powdered cochineal in 1 quart of water till the coloring-matter is extracted. Let the cochineal subside and pour the liquid into another vessel. When cold, gradually add some chloride of tin, with constant stirring, till the supernatant fluid on standing becomes nearly colorless; then add a little powdered alum. Assist solution by stirring, and allow to subside. Pour off the excess of liquid, wash the colored residue with three or four waters to remove the acid, and dry carefully and slowly. The addition of cream of tartar during the process will give a purple tint.

Vermilion may be used for red ink where neatness is required, as for the title-lines of books. The quantity of it employed varies very much and necessitates care in its proportions. For cheap work, such as posting-bills, *red lead* may be used. It requires additional soap to make it work clean, and its color soon changes to black.

An excellent permanent red of rich tone may be produced from *Indian red*. *Venetian red* is easily ground into a smooth ink; it is, however, not very intense.

The highest *yellow* is obtained from *chromate of lead*; it is readily ground into a fine ink and works freely and well. *Yellow* ochre is easily ground into a fine ink. It gives a useful color, dull, but permanent.

Pale and not accurately definable colors are mixed with white lead and various yellow, green, blue, and red pigments.

The following are a few receipts for colored printing inks:—

Red printing ink.—I. Pure oil varnish 10 parts, carmine 6.

II. Pure oil varnish 10 parts, carmine 4, red lead 2.

III. Pure oil varnish 10, carmine 2, red lead 4.

Blue printing ink.—I. Pure oil varnish 10 parts, *bleu d'acier* 3.

II. Pure oil varnish 10, best ultramarine 2, white lead 2.

III. Pure oil varnish 10 parts, Paris blue 3.

Green printing ink.—Pure oil varnish 10 parts, best chrome green 5.

Yellow printing ink.—Pure oil varnish 10 parts, best chrome yellow 4.

White printing ink.—Pure oil varnish 10 parts, white lead 5.

Copper-plate printing inks.—These inks are also prepared from a varnish and coloring-matter. However, for black, the ordinary lampblack cannot be used, the heavier vegetable black being substituted for it. *Frankfort black* or *drop black* is especially suitable for the purpose. This black is made from a great variety of materials of an organic character, such as vine twigs, refuse of wine-making, peach-stones, hop-bine, bone shavings, ivory cuttings, etc. These materials are calcined in a closed vessel until they are thoroughly charred. The black thus obtained is ground up as fine as possible with a little water. The mass is then lixiviated to free it from soluble matters and dried. It is next mixed with a little glue-water and made into pear-shaped drops for sale, for which purpose they are ready when dry.

Frankfort black is of fine texture, and varies in hue from a bluish-black to a somewhat reddish-black, which is due to the different materials of which it is made, vegetable matters yielding a black of a bluish hue, while animal matters give a black of a grayish hue.

Copper printing ink may be prepared as follows: Boil 1 gallon of linseed oil in a dry boiler until it will readily ignite by applying lighted paper. Let it burn 10 minutes, and then extinguish the flame by putting the lid on the boiler. Now add about 4 ozs. of litharge and stir well. When cool, ready for use, mix a little of this oil with lampblack, forming a thick paste, and grind it very fine with a muller. The grinding is most important.

Black.—Frankfort black, finely ground with linseed oil.

Red.—Mineral orange-red 5 parts by weight, Chinese red 2.

Blue.—Celestial blue 2 parts by weight, marine blue 3.

Green.—Mineral green 2 parts by weight, chrome green 3.

Brown.—Burnt umber 2 parts by weight, rose-pink 1.

Lilac.—Prussian blue 1 part by weight, Chinese red 2.

Pink.—Mineral pink 2 parts by weight, satin-white 1 oz.

Orange.—Orange-red 2 parts by weight, flake-white 1.

The above to be mixed and ground with Canada balsam. *Or*

Red, vermilion; *yellow,* King's yellow; *blue,* smalt; *green,* King's yellow green; *brown,* burnt umber; *dark brown,* burnt umber and Frankfort black; *puce,* Frankfort black and vermilion; *brown,* Frankfort black and drop lake.

These to be ground and mixed with nut or linseed oil.

Gold.—Gold bronze mixed with dark oak and mahogany varnish.

Silver, copper, ruby.—The same as gold, merely substituting the different bronzes. Cards printed in gold, silver, or colors should, when dry, be placed on a very smooth copper- or steel-plate, not engraved, and passed through a copper-plate press with rather a tight pressure. This would also improve the appearance of cards printed in like manner with letter-press.

X.

FABRICATION OF SEALING-WAX.

SEALING-WAX is said to be an East Indian invention which first became known in Europe in the middle ages. It seems that its use was first introduced in Spain, and from there spread over the rest of Europe, at least the respective names given to it would indicate this. The French word for it is "circe d'Espagne," and the Italian "cera di Spagna" (Spanish wax). The English word "sealing-wax" is synonymous with the German word "Siegelwachs," and it originated very likely from the fact that, before the present composition of sealing-wax was known, colored wax was generally used for sealing letters, as is yet done at the present day for stamping seals upon deeds and public documents.

Sealing-wax, in general, consists of a mixture of resins to which turpentine, essential oil, and fragrant balsams are added, partly for the purpose of diminishing the natural brittleness of the resins as well as to facilitate their melting by heat, and partly to impart to them a sweet odor; besides various coloring substances are mixed with them.

Good sealing-wax should be smooth, glossy, and not brittle; it must bear the highest summer temperature without becoming soft, and when burnt must melt readily without evolving smoke or a disagreeable odor, but at the same time must not become so thinly-fluid as to drop. The seal made with the wax should have the same appearance as the unmelted sealing-wax, *i. e.*, it must neither change its color nor lose its lustre. The fracture of good sealing-wax should be smooth, not too lustreless, and especially must not have an earthy appearance.

The fabrication of sealing-wax can be very conveniently combined with the manufacture of varnish, as the resins also play an important *role* in this branch of the industry; indeed, they are here even of greater importance, they constituting the principal materials used.

Materials used in the Fabrication of Sealing-Wax.

A large part of the materials used for sealing-wax have already been mentioned in treating of the substances used for the fabrication of varnishes, and, as far as these are concerned, we would refer the reader to the chapter on "Raw Materials."

The principal materials used for sealing-wax are shellac and turpentine. But, besides these, several other kinds of resins are used, such as mastic, sandarac, and benzoin for the finer qualities; colophony and pitch. Fragrant balsams, balsam of tolu, balsam of Peru, as well as sweet-scented oils, such as oil of lavender, oil of mace, oil of cloves, etc., are added to hide the disagreeable odor of the burning resin.

But the coloring substances are of great importance as well as those which may be called indifferent substances, which only serve the purpose of augmenting the entire mass without exerting any influence upon the composition. Such substances, which must generally be of a white color, are, for instance, chalk, gypsum, zinc-white, and carbonate of magnesia. Sometimes brick-dust is used as an indifferent substance for common qualities of sealing-wax.

Principal Materials.—It is absolutely necessary that the shellac to be used for the finer qualities of sealing-wax should be bleached, as the reddish-brown coloring-matter adhering to the natural shellac would exert a disturbing influence, especially upon light and delicate colors which are most popular in the more expensive varieties of sealing-wax. Unbleached shellac can only be used for dark-colored sealing-wax, brown to black, as the color of the shellac will be covered by the dark coloring substances which will have to be added. It is always advisable for the manufacturer of sealing-wax who buys large quantities of shellac, to bleach it himself. If it is desirable to exercise particular economy, a light-colored variety of shellac may be used instead of bleached shellac for light-colored, but not very fine qualities of sealing-wax, though the colors will be less beautiful.

Turpentine is the next principal material which is used, and Venetian turpentine is to be preferred to any other kind. But colophony and oil of turpentine may be used as very suitable substitutes for turpentine, and this besides offers the great advantage that it is always in one's power to regulate at will the fluidity of the mass by adding a larger or smaller quantity of oil of turpentine.

As most commercial turpentine is contaminated by splinters of wood, leaves, etc., it cannot be used immediately, but has to be filtered to free it from these admixtures. This is a tedious labor on account of the viscid condition of the turpentine, but it can be accomplished in the quickest way by heating the turpentine in a vessel filled with water heated to a temperature of 212° F., and filtering it through a linen cloth.

Resins, such as mastic and elemi, are only added in small quantities and, for the finer qualities of sealing-wax, to the actual base of the sealing-wax, which is composed of shellac and turpentine, or of shellac, colophony, and oil of turpentine. Benzoin, balsam of Peru, and the other essential oils are only used for the perfumed varieties. In respect to the last-named substances, we would recommend that they be procured from a reliable firm, and that rather a higher price should be paid for them than might be asked for them in another store, as such articles as balsam of Peru and essential oils are found, only too frequently, badly adulterated and sometimes contain but a small percentage of the substances whose names they bear.

Pigments which are used in the fabrication of sealing-wax.—A large number of coloring substances are used, as there is at present a demand for sealing-wax of all colors, and it is brought into the market in all possible shades. The best plan for the manufacturer is not to prepare the pigments himself, but to buy them. It may be recommended to prepare only some few colors for which an extraordinarily high price is asked in the stores.

Red pigments.—Of all colors employed, red is the one of which the largest quantities are used. We know a considerable number of red coloring substances which may be used for coloring sealing-wax. For the sake of economy, it is, of course, necessary to use cheap coloring substances for ordinary kinds of sealing-wax, but they never give such a beautiful appearance to the article as the finer ones. For instance, the beautiful scarlet color of fine red sealing-wax can only be produced with the aid of vermilion or cinnabar; but not with minium (red lead), colcothar, etc.

Vermilion or cinnabar is generally prepared artificially, namely, by heating mercury with sulphur. The chemical name of vermilion is mercuric sulphide, and it has the formula HgS. This expensive coloring-matter is but seldom adulterated, as a very slight addition of other red coloring substances injures the fiery appearance on which depends its commercial value. The purity of vermilion can be readily ascertained by heating a small quantity of it red-hot. If the article is pure, it will volatilize without leaving a residue.

In consequence of its great weight, vermilion would make the sealing-wax too heavy, and it is, therefore, necessary to add a certain quantity of an indifferent substance to be colored with it, which will make it less dense.

Red lead or minium.—Commercial minium has several shades of color, according to the degree of heat at which it has been prepared. The color varies from a shade inclined towards orange to a beautiful scarlet. The tint of some kinds of minium can be considerably improved by careful heating upon bright sheet-iron, but the temperature must not be allowed to rise too high, as this would cause discoloration.

Red oxide, Indian red, iron reds.—Ferric oxide, the red oxide of iron, is the basis of a large number of red pigments which are sold under the names of rouge, light red, Indian red, red oxide, Venetian red, purple oxide, scarlet red, etc., which are all red pigments of varying shades of color. The most beautiful kind of this coloring-matter is obtained as follows: Green vitriol is dissolved in rain-water, the solution filtered, and to this a filtered solution of binoxalate of potassium in rain-water is added as long as a precipitate is formed. After a few hours, the fluid standing over the precipitate is poured off, the latter is stirred up with some rain-water, and is again allowed to settle. This is several times repeated, the precipitate is then collected upon a cloth, and dried in a place where it is protected from dust. The yellowish-green mass which has been collected upon the cloth is rubbed very fine and heated in a porcelain dish under constant stirring. When a certain degree of heat has been reached, it catches fire and gradually subsides into a very fine powder of a fiery, but pleasant reddish-brown color. A good quality of the pigment thus produced gives sealing-wax of a very fine color. This coloring-matter is also known as colcothar and *caput mortuum*.

Bole is a clay colored red by being mixed with more or less sesquioxide of iron; a darker coloring may be imparted to it by mixing it with red chalk; but this, as well as the commercial red oxide, can only be used for common kinds of sealing-wax.

Carmine is such an expensive pigment that it is scarcely possible to use it even for the finest qualities of sealing-wax, though directions are given in many books how to prepare sealing-wax of a bright red color with the assistance of it.

Vienna lake and madder-lake are combinations of different red coloring substances with alumina, protoxide of lead, and oxide of zinc. At the present time these lakes are prepared of an excellent quality, and in all shades of color. The manufacturer of sealing-wax should always choose the most fiery article, and that most thoroughly saturated with color he can find.

Yellow pigments.—Yellow sealing-wax is frequently demanded as an article of luxury, and yellow pigments are also frequently used for various mixed colors, or for preparing sealing-wax which shall show different gradations of color.

Chrome-yellow.—This is without doubt the most beautiful of all yellow pigments, and can be readily made by dissolving sugar of lead in rain-water and adding to this a solution of bichromate of potassium as long as a precipitate is formed. This precipitate is washed, dried, and then forms a bright yellow powder consisting of chromate of lead, and in commerce is called chrome-yellow. On account of its sombre color and great weight, chrome-yellow is generally not used in a pure state, but is mixed with chalk, magnesia, or some other white substance.

Mineral yellow or Cassel yellow is a beautiful yellow color produced by carefully fusing litharge, and by grinding and washing the powdered mass. It is also remarkable on account of its great weight.

Ochre is a yellow or yellowish-brown earth, and can only be used for ordinary kinds of sealing-wax, as it does not possess a warm tint of color, and besides has the disagreeable property of giving an earthy smell to the sealing-wax, even if it is added in very small quantities.

Green pigments.—For coloring sealing-wax green, it is always best to use a mixture of a yellow and a blue pigment, or the green ultramarine. To be sure, there are very beautiful green pigments, such as the genuine green cinnabar and chrome-green, but they are entirely too expensive for use in the fabrication of sealing-wax, and besides their use is not to be recommended, as the same shades of color possessed by these expensive pigments can be produced by a suitable mixture of yellow and blue.

Blue pigments.—Ultramarine and mountain blue are used for the lighter tones, and Berlin blue for the darker shades. As ultramarine is inexpensive, it may used even for very cheap kinds of sealing-wax.

Brown pigments.—Several earthy substances known as umber, sienna, burnt sienna, Cassel brown, etc., are used for producing beautiful brown colors. Burnt sienna especially possesses a very beautiful warm tone of color, and for this reason is to be preferred to other brown pigments, and also on account of its being a very productive and very cheap pigment.

Black pigments.—Finely divided carbon, which, according to its origin, is called lampblack, ivory-black, Frankfort black, etc., is alone used for giving a black color to sealing-wax. Frequently, these different kinds of black pigment can only be bought at very high prices; but it is not at all necessary to use them for the fabrication of sealing-wax, as common lampblack, if well prepared, answers all purposes.

Commercial lampblack has frequently a brownish shade of color due to adhering products of tar, and a disagreeable smell which is especially observable in burning sealing-wax prepared with it. Lampblack may be prepared in a simple manner by carefully calcining it. This will remove the disagreeable smell, and at the same time a pure black color will be obtained.

Generally, a stove-pipe about 20 inches long, and closed on both ends by well-fitting covers, is used for this purpose. The pipe is filled with the lampblack to be calcined, in such a manner that when gently pressed into the pipe it comes up to about 1½ to 1¾ inches below the upper rim. The upper lid, through which a hole of about the thickness of a straw has been made, is then placed tightly upon the pipe, and all the joints are smeared over with clay. It is also advisable to cover the entire pipe with clay to prevent it from being burnt through.

The pipes filled with lampblack are then placed in an air furnace in such a manner that the perforated cover is uppermost, and brought to a red heat. When the attendant is convinced that the entire mass is thoroughly calcined, the fire is extinguished, and after twenty-four hours the pipes are opened—or, at least, not before the entire contents have become cold. The bad-smelling tar products, which gave a brownish color to the lampblack, have been destroyed, and the latter is now entirely odorless and of a velvety-black color.

Frankfort black or drop black is a beautiful black pigment which can be prepared at a nominal cost in wine-growing countries. The same kind of sheet-iron pipes mentioned above are used for preparing it. The pipes are filled with pieces of vine-shoots and heated as long as gases escape from the hole in the upper lid, but the hole should be made somewhat larger than for ordinary lampblack. The carbonized residue remaining in the pipes is put into a vessel filled with water, which has to be changed several times for the purpose of dissolving the alkalies. To the last water but one, a quantity of hydrochloric acid equal to one-fourth of the volume of water is added to dissolve the last traces ot alkaline substances. The residue, when rubbed fine and washed, is the finest black. It is mixed with a little glue-water and made up into pear-shaped drops, which are dried (see p. 259).

White pigments.—White substances are added to sealing-wax for three reasons, namely, first, to decrease the weight of the wax which has been colored with very heavy pigments, such as cinnabar and chrome-yellow, and at the same time to increase the bulk of the sealing-wax; secondly, to obtain lighter-colored masses of sealing-wax; and thirdly, to impart an actually white color to it.

In the first two cases mentioned it does not matter much what the nature of the substance is which is added to the mass of the sealing-wax, provided it is of a pure white color and of but little weight. But in the last case, where the white substance is also to serve as the actual coloring-matter, its nature must be taken into special consideration, and only such substances should be chosen as will give to the sealing-wax a beautiful white appearance resembling enamel. A special effort should be made to obtain this appearance in all other varieties also, with the exception of transparent sealing-wax, as seals made with such a product are the most beautiful.

Chalk.—Chalk occurs as a mineral in many places in such masses as to form regular mountain chains. The coast of a great part of England, the island of Rügen, etc., consist of chalk-cliffs. Chalk consists essentially of the same substances as white marble, that is, of carbonate of lime. It presents very peculiar forms under a strong magnifying glass, and we know now that all chalk has been formed from the remains of minute animals or plants in whose shells the mineral substance was present.

Chalk, as found in nature, contains many inclosures, such as flints, sand, petrifications, etc., and, therefore, must be especially prepared before it can be used for the various purposes for which it is employed (for writing, paints, etc.). This is effected by grinding and washing it, and by forming the powder into a dough with water, to which has been added a very small quantity of some kind of paste. This is then dried and cut into pieces, and furnishes the chalk for writing. For our purposes it is sufficient to wash the chalk and to dry the powder. The principal property of chalk, fit to be used for the fabrication of sealing-wax, consists in its pure white color.

Gypsum is also a frequently occurring mineral. In the preparation of sealing-wax only the product known as plaster of Paris is used. It is obtained by calcining and then grinding ordinary gypsum. The variety of gypsum occurring in colorless crystals, and known by the name of specular gypsum or selenite, is used for the transparent variety of sealing-wax. Before using the selenite, it must be powdered and washed.

Carbonate of magnesia is found in commerce as a dazzling white, very fine powder, which is uncommonly light. Magnesia being dense and at the same time of a yellowish color—caused by a small quantity of sesquioxide of iron contained in it—is of less value. Carbonate of magnesia is especially valuable to the manufacturer of sealing-wax on account of its light weight, and is particularly used as an addition to such sealing-wax as is compounded with heavy pigments.

Zinc-white is found in commerce as a milk-white, fine powder, and can be used without further preparation.

Barytes (*sulphate of barium*).—This white pigment, distinguished by its great weight and unchangeableness, can be procured in commerce, and is especially adapted to preparing white, enamel-like varieties of sealing-wax.

Sulphate of barium is prepared by dissolving chloride of barium in rain-water, and by adding sulphuric acid to the solution as long as a precipitate is formed. On account of its great weight, the precipitate of sulphate of barium (permanent white) settles quickly to the bottom and forms a very delicate powder of a dazzling white color. The water is poured off from the precipitate and clean water poured over it, the process being repeated several times. When the precipitate has been sufficiently washed, it is dried.

Nitrate of bismuth, or flake-white, produces the most beautiful white color, but commands a high price. For this reason it is advisable for the manufacturer to prepare this pigment himself, especially as it can be done with very little trouble. Nitrate of bismuth, or flake-white, is obtained as follows: Bismuth is placed in a glass vessel and fuming red nitric acid poured over it. The acid has a strong effect upon the metal, suffocating reddish-brown vapors are formed, and the bismuth is gradually dissolved.

When solution is complete, the contents of the glass are poured into a vessel containing about one hundred times the quantity of rain-water, and stirred. The entire fluid assumes at once a milky appearance, and in a few hours the nitrate of bismuth will have settled to the bottom in the form of a white powder. This is then washed and dried. The fluid standing over the precipitate still contains some bismuth in solution, and is evaporated until crystals are formed; these are again dissolved in nitric acid and the operation repeated. The nitrate of bismuth or flake-white obtained in this manner furnishes the most beautiful, enamel-like, white sealing-wax.

Bronze-powders in all possible shades are also used as an addition to various kinds of sealing-wax. Finely powdered mica is used for the cheaper, so-called aventurin sealing-wax, which shows yellow or white spangles of a metallic lustre in a transparent basis-mass. Mica is a frequently occurring mineral, and, as is well known, is also used as a sand for drying ink.

All the materials used in the fabrication of sealing-wax, whether they are resins or pigments, must be thoroughly dried before use. To save the expense of a special apparatus for drying them, it is advisable to utilize for this purpose the heat developed by the stove upon which the mass for the sealing-wax is melted. For this purpose a shelf is placed all around the walls, about 20 inches below the ceiling of the room in which the stove stands, and the materials, resins, chalk, magnesia, pigments, etc., are put up in paper bags and placed upon this shelf. As the warm air from the stove always rises to the ceiling of the room, the materials will be sufficiently dried when they remain for a few days in this warm air.

The mass for sealing-wax is prepared as follows: The actual raw materials, namely, the resins and turpentine, are first melted in suitable vessels, then the indifferent substances, such as chalk, magnesia, etc., are stirred into the fluid mass, and finally the pigments are added. If the mass is to be perfumed with balsam of Peru or essential oils, they are added to it just before forming it into sticks, as they are very volatile.

If only one pigment alone, for instance vermilion, chrome-yellow, or Berlin blue is to be used, nothing remains to be done but to add the pigment, previously somewhat warmed, to the mass, and to incorporate it with it thoroughly by continual stirring. But where certain shades of color, such as rose-color, violet-blue, or mixed colors, such as orange, green, or violet, are to be produced, a somewhat different method has to be used.

No white substances are then added to the resins, they being kept back and mixed with the coloring substances in a porcelain dish large enough to hold the entire quantity of white substance and coloring substance to be used. The dish is placed upon a stove so that the materials may become warm, as thus they can be more readily incorporated with the melted mass of resin. For lighter shades, for instance, rose-color, a dark red pigment, such as madder-lake, is mixed with a sufficient quantity of the white substance to give to the mixture a far darker color than required for the sealing-wax, as the shade of color desired for the finished product can be easily produced by gradually adding white substance with frequent testing.

Any of the previously mentioned white substances can be used for producing a lighter shade of color, and by increasing the quantity of them all possible gradations of color may be obtained. In a similar manner all shades of orange can be obtained by a suitable mixing of yellow with red; of green, by mixing yellow with blue; of violet, by mixing red with blue. For gray, a small quantity of black is added, etc., etc. It must be left to the experience of the workman to hit the right shade of color by a suitable mixing.

Melting the Sealing-wax Mass.

This is the most particular work in the manufacture of sealing-wax. It must be accepted as a principle in regard to this work, that the mass should be melted at as low a temperature as possible, and the heat should never be greater than is required to keep the mass in a fluid state. This object can be attained only by working a not too large quantity of sealing-wax at one time in the melting vessel. It is best to use a vessel in which can be prepared about 22 lbs. of finished sealing-wax, and large enough to allow of the mass being quickly stirred.

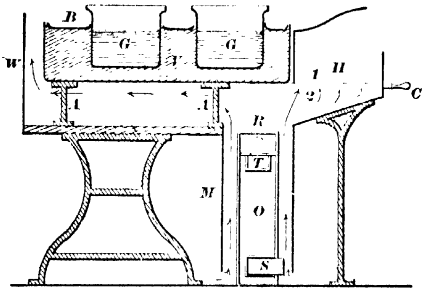
Many manufacturers melt the mass upon a furnace constructed like a common cook-stove, where the fire heats cast-iron plates upon which the articles to be heated are placed. But such a stove is a very incomplete apparatus, as it is impossible to heat uniformly the entire surface of the plates, those exposed most to the fire being generally already red-hot while the more distant ones are scarcely warm. But independent of these evils, such stoves are always somewhat dangerous on account of fire. One drop of the fluid mass when ladled out may fall upon the hot plates, become ignited, and communicate the flame to the contents of the melting vessels; and though a fire might be prevented by quickly covering the latter, the mass would, in most cases, be spoiled, because burning sealing-wax turns black.

By the use of the melting apparatus shown in Fig. 39, the evils above mentioned are avoided, and it is possible to regulate the temperature so accurately that it will not rise higher than is actually required. This apparatus serves at the same time for the so-called polishing of the sealing-wax, and therefore does away with the necessity of building a special polishing apparatus. The illustration shows the apparatus in cross-section.

Melting apparatus.—This consists of a small furnace, *O* (Fig. 39), about 3¼ feet high; the upper door *T* serves for introducing the fuel, small pieces of coke such as is furnished by gas-works being best for the purpose. The lower door can be either partly opened or entirely closed by a slide, *S*, by which the consumption of the fuel is regulated. There is no grate in this stove; the ashes are removed through the lower door. The gases of combustion pass into the chimney through the pipe *R*.

The stove is entirely surrounded by a sheet-iron jacket, *M*, which stands at a distance of about 2 inches from the stove, and the same distance from the floor. The air between the jacket and the stove becomes hot,

Fig. 39.



ascends in the direction indicated by the arrows, and is replaced by cold air flowing in between the jacket and the stove.

Alongside of the jacket, and connected with it, stands a table surrounded on all sides by a sheet-iron screen, *W*. Upon the table stands a sheet-iron tub, *V*, filled with sand, and resting upon iron supports, *AA*. The tub is covered with a sheet-iron plate, *B*. In this plate are four or six round holes in which the melting vessels, *GG*, are placed in two rows. On the bottom of the polishing hearth *H* is a plate, 1, which is cut in such a man-as to give it the appearance of a grate. Underneath this plate is a similar one, 2, which can be shifted by the handle *C* in such a way that the cuts in the two plates cover each other. If it is desired to use all the available heat for melting, the cuts in plate 1 are closed by shifting plate 2.

The hot air arising from the stove heats the tub *V* and the sand contained in it, and the mass of sealing-wax contained in the vessels *GG* commences to melt. As soon as it is melted, the fire in *O* is moderated by partly closing the lower opening by the slide *S*, and it is possible to keep the mass for a long time in a fluid state without a stronger heat being required, as the hot sand retains the heat. The sheet-iron plate *B* which covers the sand is placed there for preventing the loss of such sealing-wax as might accidentally drop in ladling it out of the melting vessel.

Well-enamelled cast-iron pots of the shape shown in the illustration should be used for melting, and a special pot for every mixture. If a pot has to be used for a differently colored mass, it should first be allowed to become entirely cold, when the sealing-wax still adhering to the sides can be easily removed from the smooth surface.

Melting is effected as follows: The shellac is first placed in the pot and fused, under constant stirring with a flat paddle of hard wood. The turpentine is then added and intimately mixed with the shellac. Then the remaining substances, such as chalk and coloring-matter, are dropped in a thin stream into the melted mass, which from this time on should be stirred uninterruptedly. Quick stirring is absolutely necessary, especially when very heavy coloring substances are used, as these easily sink to the bottom.

When the entire mass seems to be uniform, it is examined by lifting the paddle and catching the dropping sealing-wax upon a cold, smooth plate of sheet-metal, where it quickly solidifies, and can then be examined in regard to color, hardness, and fracture. If the mass is found satisfactory, the fire is sufficiently moderated to keep it in a fused state, the substances for perfuming the wax are quickly stirred in, and the moulding of the sticks is immediately proceeded with.

Moulding the Sealing-Wax.

Special moulds are required to shape the sealing-wax into sticks. These consist of one piece for rectangular, square, or triangular sticks, but must be of two pieces for round or oval sticks. In the latter case, one-half of the mould is provided with holes into which fit protuberances on the other half to prevent it from shifting. For use, the two halves of the mould are firmly pressed together by a screw-clamp.

The moulds of one piece are made of rectangular brass plates, in which are hollowed out lengthwise channels about 0.039 inch wider at the top than at the bottom, which very much facilitates the lifting out of the cold sticks. As both ends of the channels are left open, iron plates are laid on the narrow ends of the mould to prevent the sealing-wax from running out when poured into the channels. These moulds are generally twice as long as the sticks of sealing-wax found in commerce.

The moulds of two pieces, each half of which forms a half-cylindrical channel, which, when the mould is closed, form an entire cylinder, stand generally upright when used for moulding. They are, therefore, made somewhat broader on the bottom, and are set upon a level metal plate. These moulds are only as high as the stick of sealing-wax is to be long.

Many manufacturers place the moulds upon a stone, or cool them off while moulding, by laying them upon boxes of sheet-metal filled with cold water, for the purpose of congealing the mass as quickly as possible. Of course, by employing this method, the moulds can in a very short time be used again after each moulding, but the sticks of sealing-wax become too brittle. It is, therefore, preferable not to cool off the moulds, but to place them upon a wooden table. A good plan is to cool off the mould by simply dipping it in cold water, and carefully drying it, when it has become so hot that the sealing-wax would require a long time for congealing.

The work of lifting out the congealed sticks is easily accomplished if the moulds are entirely plain; but if engraved, they must be touched up for a long time before the sticks can be lifted out clean. In such cases it is advisable to slightly rub the engraved places with oil of turpentine. If the sealing-wax is to be gilt or silvered on certain places, the gold-leaf or silver-leaf is placed in the mould, or it is dusted with bronze-powder.

Brass moulds are rather expensive on account of the cost of engraving. But they can be constructed very cheaply by a simple method, and only one single mould is required for the purpose, but this must be worked in a faultless manner. A stick of fine sealing-wax is moulded in this mould. Fine olive oil in as thin a layer as possible is then rubbed with a tuft of fine cotton over the surface of the stick of sealing-wax. The oiled stick is laid in a longish mould and plaster of Paris poured over it. When this has become hard it is carefully detached from the stick and thoroughly dried at a moderate heat. It is then rubbed over with olive oil and a stick of plaster of Paris moulded in it, which resembles in every respect the first casting of sealing-wax. When the stick of plaster of Paris has been thoroughly dried, it is placed in a small wooden box and melted type-metal poured over it; but this must not be heated any more than absolutely necessary to bring it to the melting-point. In this manner moulds of type-metal are obtained which can be used like the brass moulds. Many copies can also be made from a single form by the galvano-plastic process.

The moulding process is carried on in the following manner: The melted sealing-wax is taken from the melting vessel with a ladle and poured into a casting-ladle provided with a spout and a wooden handle, which has been previously heated. From this it is poured in a uniform stream into the moulds. The moulds consisting of one piece are covered with a board when the sticks have become cold; they are then turned over and the sticks are detached from the channels of the forms by a gentle tap. Moulds consisting of two pieces are opened and the sticks pushed out. In regard to these moulds it may be mentioned that clean moulded sticks can only be obtained by slightly heating the mould before making the first casting, which can be done in the simplest manner by placing it upon the plate *B* of the melting apparatus.

Variegated sealing-wax, which should show a marbled surface, is prepared by moulding sticks about as thick as a quill and placing them alongside of each other. They are then sufficiently heated to become soft, are twisted regularly together into spiral lines, and rolled into a cylinder upon a smooth stone slab.

Polishing the Sticks of Sealing-Wax.

Only the finer qualities of sticks of sealing-wax obtained from the moulds show a certain lustre upon their surfaces. Poorer qualities do not possess this lustre, but it must be imparted to them by a special operation which is called polishing, dressing, and also enamelling. As nearly every kind of sealing-wax bears an inscription or stamp, the stamping is done at the same time as the polishing. The finer sorts are generally also polished, though as a rule they come from the mould in a smooth state.

In older factories there is a special polishing stove for this purpose. This consists of a chamber built of brick. On the bottom of this is an iron plate which is strongly heated by a fire made under it, and heating also the air in the chamber. The same object may be attained by the contrivance *H* shown in Fig. 39, which consists of a box of sheet metal or wood open in front and into which hot air is admitted by shifting the plate 2. The air need only to be hot enough to melt in a short time the surface of the sticks of sealing-wax.

The polishing process is carried on as follows: A workman holds a number of double-length sticks, without one stick touching the other, half-way into the polishing stove, until the surface of the sticks commences to melt and the sticks themselves become bent. When this takes place, he places the sticks before a workman sitting opposite to him. The latter pushes the sticks upon a small board lying before him, and with the left hand presses another small board upon the second length of the stick and imprints the stamp. It is necessary to hold the sticks between these two small boards, as their shape is easily destroyed, especially if they are very soft and the "stamper" uses too much force in imprinting the stamp. When they have been stamped, the first workman takes them again and holds the other half, which has not yet been polished in the polishing stove, and then the second workman stamps these also. The stamps consist of brass frames in which the single letters of which the inscription is composed are placed and held in place by a screw, or they consist of an engraved brass-plate. The last-named stamps serve generally the purpose of imprinting ornamentations and arabesques upon the sticks.

The double-length sticks are now cut apart. This is done as follows: 30 to 40 sticks are laid alongside of each other, and are scratched exactly in the center with a sharp knife and by using a ruler. They are then turned over and scratched on the other side also. If both scratches are exactly opposite to one another, the sticks can be easily broken smoothly apart on these places, and the fractures need only be slightly polished to finish the article.

If the finished sticks of sealing-wax are to be gilded or silvered, it is only necessary to touch the respective places with a brush dipped in strong spirits of wine, and to apply the gold leaf or silver-leaf, which will then adhere very tenaciously. The sticks can also be bronzed in a similar manner.

Receipts for Sealing-Wax.

There are a great number of receipts according to which one or the other kind of sealing-wax is to be prepared. In the following, only comparatively few receipts are given, but all of them have produced good results. This is the case even with the cheaper qualities, which, under the name of parcel-wax, are used for sealing packages, although, of course, they do not possess the excellent properties of those qualities of sealing-wax which are prepared by using the finest materials.

Red sealing-wax.—As is well known, red sealing-wax is more used than any other variety. Its beauty and its price are determined by the quantity of shellac and vermilion contained in it; only the finest qualities contain vermilion exclusively as a coloring principle. The inferior kinds contain very little shellac, but much common resin, and no vermilion at all; minium, colcothar, bole, or other cheap pigments being substituted for the latter.

As a general rule, too much resin must not be added to the sealing-wax, otherwise it will become too thinly-fluid, drop too easily, and smoke very much when lighted. Many manufacturers assert that chalk should not be used, because the acids of the shellac expel carbonic acid from it and form a combination with the lime. But this happens only when the shellac is heated more than is necessary. No carbonic acid is set free if the shellac is heated only to the melting-point, and it is not required for our purposes to heat it any further.

Finest quality of red sealing-wax.—1. Shellac 120 parts, turpentine 80, vermilion 90, oil of turpentine 20, magnesia 30.

II. Shellac 110 parts, turpentine 60, oil of turpentine 10, chalk 10, magnesia 20, vermilion 80.

III. Shellac 100 parts, turpentine 10, oil of turpentine 5, chalk 15, gypsum 15, magnesia 2, vermilion 65.

Medium quality red sealing-wax.—I. Shellac 10 parts, turpentine 80, oil of turpentine 4, chalk 30, magnesia 10, vermilion 60.

II. Shellac 60, rosin 40, oil of turpentine 4, turpentine 70, chalk 15, gypsum 15, vermilion 45.

III. Shellac 40, rosin 60, turpentine 60, oil of turpentine 5, chalk 20, gypsum 10, vermilion 40.

Ordinary red parcel sealing-wax.—I. Shellac 35 parts, rosin 65, turpentine 50, oil of turpentine 5, chalk 25, gypsum 10, vermilion 25.

II. Shellac 20 parts, rosin 80, turpentine 50, oil of turpentine 5, chalk 30, gypsum 5, red lead (minium) 60.

Very ordinary red parcel sealing-wax.—Shellac 15 parts, rosin 85, turpentine 60, oil of turpentine 5, chalk 20, brick-dust 10, red oxide (colcothar) 50.

R. Wagner's Receipts for Preparing Sealing-Wax.

A. *Fine Red Sealing-Wax.*

	I. Parts.	II. Parts.	III. Parts.	IV. Parts.	V. Parts.
Shellac	550	620	550	700	760
Turpentine	740	680	600	550	410
Chalk or magnesia . .	300	200	—	—	—
Gypsum or zinc-white . .	200	—	—	—	—
Sulphate of barium . .	—	100	380	300	320
Vermilion	130	220	340	300	540
Oil of turpentine . . .	—	—	—	20	40

B. *Ordinary Red Sealing-Wax.*

	I. Parts.	II. Parts	III. Parts.	IV. Parts.	V. Parts.
Shellac	520	490	620	710	740
Turpentine	600	580	520	600	420
Pine resin	440	440	320	210	160
Chalk	180	—	—	100	—
Sulphate of barium	—	320	300	—	120
Vermilion	180	130	200	400	520

C. *Black Sealing-Wax.*

	I Parts	II. Parts.	III. Parts.	IV. Parts	V. Parts.
Shellac	480	560	660	740	680
Turpentine	520	440	420	380	360
Pine resin	460	500	400	340	300
Chalk	280	180	140	140	150
Lampblack	80	—	—	—	—
Bone-black	—	420	300	300	320
Asphaltum	—	—	—	—	200

Parcel sealing-wax.—Colophony 2000 parts, pine resin 1000, turpentine 500, chalk 750, oil of turpentine 30.

For brown, 1000 parts umber are added to this mass.

Yellow sealing-wax.—Only lead colors can be used for yellow sealing-wax, and of these chrome-yellow produces the most beautiful hue. But if sealing-wax colored with chrome-yellow is very strongly heated in igniting, the mass becomes discolored in consequence of a decomposition of the lead color; therefore yellow sealing-wax must be very fusible to avoid this evil. Every kind of sealing-wax becomes more fusible by adding a larger quantity of turpentine, but it also becomes less hard the more turpentine is added.

Fine yellow sealing-wax.—Shellac 76 parts, turpentine 85, pine resin 45, gypsum 15, chalk 15, ochre 45.

The shellac used for fine qualities of yellow sealing-wax must be bleached, otherwise it is impossible to produce a pure tone of color. All gradations of yellow, from orange to red, can be produced by adding cinnabar or chrome-red to fine qualities and red lead (minium) to inferior qualities.

Fine green sealing-wax.—Shellac 70 parts, turpentine 80, pine resin 40, magnesia 15, Berlin blue and chrome-yellow mixed 30.

Ordinary green sealing-wax.—Shellac 50 parts, turpentine 40, pine resin 80, gypsum 15, chalk 20, mountain blue and ochre mixed 30.

Green ultramarine may also be used to great advantage for the finer qualities in place of a mixture of pigments. In the above receipts the quantities of the blue and yellow pigments to be used are not given separately, as the different shades of green may be obtained by varying the quantity of each pigment.

Blue sealing-wax.—Shellac 70 parts, turpentine 60, pine resin 35, magnesia 10, chalk 20, blue coloring-matter 20 to 25.

Light-colored ultramarine or mountain blue is used for light blue varieties, Berlin blue for the darker kinds. Blue sealing-wax of a lighter color, produced by mixing Berlin blue with oxide of zinc or nitrate of bismuth, has a very beautiful enamel-like appearance. As blue colors are very sensitive towards admixtures, bleached shellac should always be used if it is desired to obtain sealing wax of a beautiful color, and the greatest care must also be exercised in the choice of the pine resin. Opaque and brown-colored resin must never be used. It may be accepted as a general rule that for fine yellow, light-red, green, blue, and violet kinds of sealing-wax only light-colored materials should be used, so that the purity of tone may not be impaired.

Brown sealing-wax.—Shellac 70 parts, turpentine 60, pine resin 40, gypsum 20, chalk 20, umber 20.

The shellac used for preparing delicate chocolate-brown sealing-wax must not be too dark. The product of the above receipt is dark brown, and unbleached shellac and dark resin may be used for preparing it. Of course, the same holds good in an equal degree in regard to the following varieties:—

Black sealing-wax.—I. Shellac 50 parts, turpentine 90, pine resin 65, chalk 40, lampblack 12.

Black sealing-wax.—II. Shellac 80 parts, turpentine 60, pine resin 60, chalk 15, gypsum 10, Frankfort black 35.

By following the above receipts, the intelligent manufacturer will have no difficulty in preparing mixtures of various colors corresponding to a certain degree of fineness.

For preparing sealing-wax of different shades of color, which present an especially beautiful appearance when the differently colored single sticks are laid alongside of each other like a scale of colors, it will be advisable to arrange a normal scale of colors consisting of single sticks, the coloring of which has been especially successful. The shading of the colors in this scale must harmonize, and the sticks lying alongside of each other must show, for instance, all gradations from white through rose-color to the darkest, most fiery red, which latter is prepared with madder-lake.

For a novice, it is difficult to produce these shades of color by a suitable mixing of the coloring substances; but this can be easily acquired by experience. We will take red sealing-wax as an example, which can be prepared in different shades from the tenderest rose-pink to dark red.

The respective scale of red colors is first painted with a good water-color upon paper; this scale serves for comparing the test-samples of sealing-wax.

Further, a certain quantity of entirely white sealing-wax, 1 lb., is melted, and the same quantity of finely powdered sealing-wax of as dark a red color as possible is held in readiness. The latter is added to the white sealing-wax until a test-sample shows the shade which is desired according to the painted scale. If, now, the remainder of the powdered red sealing-wax is weighed, we know exactly how much must be added to the white mass to produce the desired red shade of color. If the white and the red ground masses are made according to the directions given, and mixed in the proportions above described, exactly the same shades of color will always be obtained.

The same method is followed with all other colors, and by a little attention the manufacturer may acquire a collection of directions by which he can produce sealing-wax of every imaginable hue.

Specialties in sealing-wax.—By specialties we understand certain kinds of sealing-wax, which are used exclusively for special purposes, such as sealing-wax for bottles, or such as are in less demand, as transparent sealing-wax, aventurin sealing-wax, etc.

Sealing-wax for bottles belongs to the most ordinary sorts of sealing-wax, and of course can only be colored with the cheapest kinds of coloring-matter. Many manufacturers prepare sealing-wax for bottles with a mixture of common pine resin, turpentine, chalk, and the proper coloring-matter only. To be sure these products are very cheap, but they do not answer the purpose as well as they should. As is well known, the corks are covered with a layer of sealing-wax by dipping the necks of the bottles into the melted mass. This congeals very quickly on coming in contact with the cold glass, and in consequence of this at once becomes more brittle, and frequently breaks when gently touched. If it is tried to make the sealing-wax less brittle by increasing the quantity of turpentine, it happens very frequently that it remains sticky even in cold weather.

To avoid these evils, nothing can be done but to add a certain quantity of shellac, 10 to 15 per cent., to the composition. This will increase the cost of the product somewhat, but its quality will be so much improved that it will not become sticky even if exported to a hot climate.

It may here be mentioned that the demand for sealing-wax for bottles has lately very much fallen off, many wine dealers, liquor manufacturers, etc., preferring metallic caps for covering the corks.

Transparent sealing-wax.—Transparent or, more correctly, translucent sealing-wax belongs to the very finest qualities, as only very refined materials can be used for preparing it. Bleached shellac alone is not sufficient;

sealing-wax becomes transparent only by adding a certain quantity of mastic, and by using only very fine and very viscid turpentine of a light color.

Below we give three receipts for preparing such masses for sealing-wax, which may be colored as desired by mixing suitable coloring-matter with them. A very beautiful variety, which can be prepared at a comparatively low cost, is the so-called aventurin sealing-wax, which is obtained by stirring finely powdered yellowish or bronze-colored mica into the melted basis-mass.

Gold or silver sealing-wax is obtained by mixing finely powdered leaf-metal with the melted basis-mass.

Basis-masses for translucent sealing-wax.—I. Bleached shellac 15 parts, viscid turpentine 15, mastic 15, chalk 10.

II. Bleached shellac 30 parts, viscid turpentine 35, mastic 40, zinc-white 20.

III. Bleached shellac 30 parts, viscid turpentine 40, mastic 50, sulphate of barium, or nitrate of bismuth 30.

The last-named mixture, No. III., is especially adapted to preparing the very beautiful so-called enamelled sealing-wax, which actually possesses the semi-transparent appearance of enamel. This mixture is especially beautiful when colored a delicate rose-color with fiery madder-lake. A seal made with this sealing-wax bears great resemblance to a cameo.

Sealing-wax for deeds, etc.—As is well known, very large seals for deeds, public documents, etc., are not imprinted in ordinary sealing-wax, but a mass which is half soft, even at an ordinary temperature, is used for the purpose, and to protect the seal from injury it is inclosed in a special case which is fastened to the document by cords or ribbons. Below we give three receipts for preparing this sealing-wax, and would remark that the product prepared according to the second receipt is very suitable for so-called embossing-wax for engravers.

Sealing-wax for deeds, documents, diplomas, etc.—I. Colophony of a light color 60 parts, turpentine 35, clarified tallow 30, whiting 40, red lead (minium) 30 to 40.

II. White wax 50 parts, turpentine 15, cinnabar 10, glycerin 5.

In both cases melt the ingredients together and, while cooling, stir until the mixture congeals.

III. Colophony 3 parts, tallow 1½, turpentine 3, chalk 4, red lead (minium) 4.

This mixture is of considerable consistency at an ordinary temperature, but if a piece of it is for some time held in the hand it becomes so soft that impressions can be taken with it, and it adheres also with considerable tenacity to paper, wood, and glass.

APPENDIX.

THE ART OF VARNISHING AND LACQUERING.

I.

The art of varnishing and lacquering includes first the preparing of putties and stains, then a description of the apparatus and tools used, rules which must be observed in varnishing and lacquering, and the means for pumicing, polishing, etc. In short, it is the art of applying colors and varnishes to articles of wood, sheet metal, and leather, and drying, pumicing, and polishing them.

Preparation of Putties required for Varnishing and Lacquering.

Putties serve for making surfaces of wood even, for filling up holes, etc., and are used before the stains and varnishes are applied.

1. *Thompson's putty.*—Boil 4 ozs. of glue in 1 quart of water until dissolved. Then add to the solution and mix thoroughly with it 1¾ ozs. powdered alum and 6 ozs. of rye flour. Next tear three or four sheets of blotting-paper into small pieces and mix them with finely sieved sawdust. Knead enough of this mixture into the glue-paste to form a tenacious putty and use the latter for filling up the crevices and holes in the wood.

2. *Putty with linseed oil.*—Mix white lead, umber, minium, and litharge to a stiff paste with boiled linseed oil, to which a small quantity of amber varnish has previously been added.

3. *Putty of isinglass and chalk.*—Dissolve isinglass in water and add finely powdered chalk to the solution until a stiff paste is formed.

4. *Hard-wood filler.*—Use boiled oil and enough cornstarch to make a very stiff paste. Add a little japan and reduce with turpentine. Add no color for white oak; for dark ash and chestnut use a little raw sienna; for walnut, burnt umber and a very little Venetian red; for bay wood, burnt sienna. Use enough color to cover the white of the starch. Apply with brush and rags. Let dry 48 hours, then sand-paper. For the second coat use less oil, but more japan and turpentine.

5. *Wood filler.*—Starch 12 parts, heavy spar 12, siccative 2, and a sufficient quantity of oil of turpentine.

Mix to the consistence of ordinary varnish, and for dark woods add up to one part by weight of umber. Apply the filler with a medium-stiff brush. When the coat, at first lustrous, becomes dull, remove everything from the surface by rubbing across the grain of the wood with a piece of felt or strong leather fastened to a piece of wood. Allow the prepared wood to dry eight hours, and then rub thoroughly with glass-paper, when it is ready for polishing.

6. *French putty.*—Boil linseed oil 7 parts with brown umber 4 parts, for 2 hours. Then add 5½ parts of chalk and 11 parts of white lead and mix thoroughly. This putty is very durable and adheres well to wood even though not previously painted.

7. *Facing putty.*—Mix whiting, white lead, and a small quantity of litharge. Then add a small quantity of drying oil. This putty is especially good for stopping small flaws.

II.

Preparation of Stains.

Wood and other articles of horn, bone, and ivory are stained for the purpose of giving to them a more beautiful color. According to their composition, the stains are applied either cold or warm with a sponge, or the articles themselves are immersed in the stain. Wood which is naturally veined becomes especially beautiful by holding it over a coal-fire and gently heating it before a warm stain is applied. It acquires by this, very beautiful dark and light streaks. The wood which is to be stained may also be placed in a boiler. The liquor is then poured over it, and boiled until the color has thoroughly penetrated the wood.

Mahogany stain.—Introduce into a bottle alkanet root 15 parts, aloes 30, powdered dragon's-blood 30, and 95 per cent. alcohol 500. Close the bottle with a piece of bladder and keep it in a warm place for three or four days, with occasional shaking. Then filter the liquid. The wood is first mordanted with citric acid and allowed to dry. The veins may be imitated by the skilful application of acetate of iron.

A cheaper preparation is as follows: Boil 8 ozs. of madder and 2 ozs. of logwood with one gallon of water. Filter the decoction while still warm, and apply the warm liquor to the wood. When dry apply a solution of pearlash, two drachms to the quart.

Another process is as follows: Dissolve ⅓ oz. of aniline in 8¾ ozs. of 90 per cent. alcohol. Then prepare another solution of ⅓ oz. of aniline yellow in 17 ozs. of 90 per cent. alcohol, and add of this solution to the aniline solution until the required color is obtained. By adding a little of a solution of aniline brown ($\frac{1}{3}$ oz. in 10 ozs. of 90 per cent. alcohol) a color very closely resembling mahogany may be given to elm and cherry.

Pfuscher prepares a mohogany stain by boiling 7 ozs. of logwood in 1 quart of water until reduced to about one-half the volume. The liquor is then filtered and 12 ozs. of chloride of barium are dissolved in it.

Red stain.—Make a decoction of 8 ozs. logwood and 1 oz. potash in 1 quart of water. Fix by a solution of alum.

Walnut stain.—Apply several coats of dilute asphalt varnish, or a solution of potassium permanganate, 1 oz. to the quart.

Another process consists in treating with a hot solution of 1 oz. of extract of green walnut shells, and when half dry applying a solution of 1 oz. of potassium bichromate in 5 ozs. of water.

Purple stain.—Boil for one hour 2 parts by weight of rasped logwood, 5 of rasped Lima red dye wood in 5 of water. Filter the decoction through a cloth, and apply it to the article to be stained until the desired color is produced.

In the meanwhile prepare a solution of carbonate of potash, 1 part by weight, in water 5. Apply a thin coat of this solution to the stained article. If too thick a coat of this solution is applied, a dark blue color, instead of purple, will be the result.

Red stain for horn, ivory, and bone.—Boil 17 ozs. of red Brazil-wood in 4 lbs. of milk of lime, and filter the decoction through a cloth. Boil the articles to be stained in a solution of 1 oz. of alum in 1 quart of water for one hour, and then place them in the stain, allowing them to remain until the desired color has been produced. By dipping articles thus stained in alum water they acquire a beautiful purple color.

Bright red stain for horn, ivory, and bone.—Boil 25 parts by weight each of logwood and Brazil-wood in 200 parts by weight of milk of lime. Apply the decoction as in the preceding.

Red stain for leather.—Introduce 25 parts by weight of red Brazil-wood into a bottle, and pour over it 200 parts by weight of wine vinegar. Digest the whole for 8 days, stirring frequently. Then filter the solution through a cloth. In the meanwhile prepare a solution of 3 parts by weight of alum free from iron in 25 parts of water, and add this solution to the filtered decoction of Brazil-wood, stirring constantly. A very beautiful red is thus obtained. The shavings of Brazil-wood may also be boiled in rain water, and the decoction mixed with a solution of bitartrate of potassium.

Cochineal stain for leather.—Digest 1 oz. of powdered cochineal in 17 ozs. of 80 per cent. alcohol until dissolved, and filter the solution. The quantity of cochineal may be varied according to whether the color is to be darker or lighter.

Black stain for wood.—I. Crushed galls 1 oz., vinegar 9 ozs. Let stand in a pot exposed to the air for half an hour, then add iron filings 1 oz.

Let stand for 2½ hours, then strain and keep in well-corked bottles. Apply with a brush or rag until the desired tint is obtained.

II. Boil 8 ozs. of galls and 2 lbs. of logwood in 2 quarts of rain-water in a copper boiler for one hour. Filter the decoction through a cloth, and while still warm apply it several times to the wood.

Black stain for horn.—Slake 5 lbs. of burnt lime with a little water so that a pulverulent hydrate of lime is obtained. Mix this with 2 lbs. of red lead, and make the mixture into a thick paste with soap-boiler's lye of 1.036

specific gravity. Place the horn articles in this paste for 24 hours; then take them out, rinse in water, dry with a cloth, rub them with rape-seed oil and rub dry

Black stain for leather.—Boil bruised galls 4 ozs., and green nut shells 17 ozs. in 1½ quarts of rain-water for one hour, and then strain the liquor through a cloth. Stain the leather to be colored with a solution of 2 ozs. of iron filings and 1 oz. of common salt in 17 ozs. of vinegar, and then apply the decoction.

Black stain for wood.—According to Herzog, wood may be stained black, so as to resemble ebony by successively treating it with two fluids. The fluid to be used first consists of a very concentrated decoction of logwood to every 35 ozs., of which ¼ oz. of alum is added. The other fluid is obtained by digesting iron filings in vinegar. The wood is dipped in the first hot fluid, and allowed to dry. It is then treated with the second fluid, the operation being several times repeated, if necessary.

Blue stain for wood.—Dissolve 10 parts by weight of French verdigris in 10 parts by weight of urine and 25 parts by weight of wine vinegar. Filter the solution and apply it to the wood to be stained. Next prepare a solution of 6 parts by weight of carbonate of potash in 25 parts by weight of rain-water, and apply the solution with a brush to the wood colored with the verdigris until the desired blue color is obtained.

Blue stain for leather.—Boil 2 lbs. of elderberries and 1 oz. of alum free from iron in 1 quart of wine vinegar for one hour, and then strain the liquor through a cloth.

Next dissolve ⅓ oz. of blue vitriol in 1¾ ozs. of wine vinegar and filter the solution.

Apply the decoction of elderberries with a sponge to the leather, and when dry brush it over lightly with the solution of blue vitriol.

Blue aniline stain.—The most recent process of staining wood is with aniline colors. The following may be used for the staining liquor: Bleu de Lyon (reddish-blue); bleu de lumiere (pure blue); light blue (greenish-blue).

The colors are dissolved in the proportion of 1 part of coloring-matter to 30 parts of alcohol, and the wood is treated with the solution.

Yellow stain for wood.—Digest 2 ozs. of finely powdered turmeric in 17 ozs. of 80 per cent. alcohol for several days and then strain through a cloth. Apply the liquor to the wood, and, when dry, burnish and varnish.

Another method is as follows: Mix 15 ozs. of nitric acid with 45 ozs. of rain-water and apply the mixture to the wood. Undiluted nitric acid gives a brownish-yellow tint.

Yellow stain for horn.—Dissolve 1 lb. of alum free from iron in 2 quarts of rain-water, and immerse the articles of bone, ivory, or horn, to be stained in this solution for one or two hours. In the meanwhile boil 7 ozs. of French berries and 4 ozs. of carbonate of potash in 1 quart of water for one hour, and then strain the liquor. Place the articles treated with the alum solution in this decoction for one hour; then take them out and dry.

Yellow stain for leather.—Digest ½ oz. of saffron cut in small pieces in 2 ozs. of 80 per cent. alcohol at a moderate heat for several days. Filter the solution and apply it directly to the leather.

Bright yellow stain for leather.—Digest 1 oz. of finely powdered turmeric and ½ oz. of gamboge in 26 ozs. of 80 per cent. alcohol at a gentle heat for a few days, and then filter the fluid. The articles to be stained are first treated with a solution of 1 oz. of carbonate of potash, or 1 oz.

of alum free from iron in 1 quart of rain-water, and are then immersed in the staining liquor for 1 hour.

Bright gold-yellow stain.—Digest ½ oz. of finely powdered madder in 2 ozs. dilute sulphuric acid for 12 hours, and filter the liquor through a cloth. Immerse the articles in the liquor for 3 or 4 days.

Gold-yellow stain for bone and ivory.—Dissolve ¾ oz. of picric acid in 1 oz. of hot water. Place the articles in dilute sulphuric acid, turning them frequently. When taken from the acid they are to be dried and immersed in the hot solution of picric acid, where they remain until they have acquired a uniform yellow color. Lustre is given to them by polishing with soap, water, and fine whiting.

Green stain for wood.—Dissolve purified verdigris 4 ozs. in vinegar 17 ozs., and apply the hot solution to the previously warmed articles until the desired tint is obtained.

Green stain for horn, ivory, and bone.—Dissolve copper in fine shavings 4 ozs. in nitric acid 13 ozs., and boil the articles to be stained in the solution until they have acquired the desired tint.

Green stain for leather.—Dissolve 1½ ozs. of verdigris and ½ oz. sal ammoniac in 8 ozs. of wine vinegar. By adding a small quantity of saffron extract to the solution, a yellowish-green color, the so-called parrot-green, is obtained.

Tortoise-shell stain for horn.—Prepare a stiff dough from 17 ozs. of white litharge, 2 lbs. of finely powdered unslaked lime, and 3 lbs. of soap-boiler's lye of 1.036 specific gravity. Cover the places of the horn which are to be dark with this dough, allowing it to remain for about 24 hours, or until it has become perfectly dry. Then cleanse the horn with a brush.

Brown stain for wood.—Alkanet root ½ oz., aloes 1 oz., dragon's-blood 1 oz., carbonate of potash ½ oz., methylated spirit 1 pint.

Brown stain for leather.—Boil 4 ozs. each of ground logwood and annotto in 1 pint of rain-water, and add to the decoction a solution of ½ oz. of carbonate of potash in 2½ ozs. of vinegar.

A brown stain is also obtained by rubbing together in oil upon a marble slab, 4 ozs. of umber, ½ oz. of best lampblack, and 17 ozs. of ox-gall.

Violet stain for leather.—Boil 1 lb. of Brazil-wood in water for one hour, and filter the decoction. Next prepare a solution of 4 ozs. of copperas in 8 ozs. of water, and mix it with the decoction of Brazil-wood. Violet stains may also be obtained by mixing red and blue stains.

III.

Workshop and Tools.

By the workshop of a varnisher or lacquerer is meant a well-lighted, spacious room, which is best located on the ground floor. It should be provided with a coal-stove, and the floor should be either of boards or of asphaltum. The room is to be kept free from dust, not by sweeping it, but by wiping it up with a wet cloth. If the room were to be swept with a broom, the freshly-lacquered or varnished article would be completely spoiled, as the dust would settle upon the wet coat of lacquer or varnish, and the result would be that the surface would not be smooth.

In the room should also be a large table with drawers, in which the different paint brushes, varnish brushes, camel's-hair brushes, pencils, etc., the spatulas of iron, wood, or bone, the rulers, and paint boards are kept.

The palettes and brayers, as well as the grinding machine for colors, are kept upon smaller tables.

In a roomy closet provided with lock and key, large and small pots, and earthen and porcelain dishes, are stored, as well as bottles of tin and glass, in which the oils and varnishes to be used are kept. The vessels for cleansing the brushes and those in which they are kept, dust-brush and all such articles, are also kept in the closet.

The room should be further furnished with several wooden horses and trestles, and a so-called drying-oven (lacquering-oven).

IV.

Lacquering and Varnishing.

By varnishing is generally understood the art of first applying any desired color to various articles of wood, stone, iron, ivory, horn, leather, clay, or sheet-metal, then to rub them, and finally coat them with varnish. By lacquering, only coating with lacquer is to be understood.

General rules.—As previously mentioned, articles to be varnished receive first a ground çolor, which is called priming. This ground-color consists of one or more coats of oil color, according to the nature of the article to be varnished. The articles, however, must be thoroughly cleansed before this ground color can be applied. This is effected by rubbing them with pumice-stone, grinding them with water and a stone, or simply by dusting them off with a feather-brush, dust-brush, etc. Every coat of the priming must be thoroughly dry before the second coat is applied, and special care should be taken that the priming is done in a place free from dust. When the coat of oil-paint has become dry, it is rubbed with pumice-stone powder and shave-grass (horse-tail), and then cleansed, which is done by washing it with a sponge and clear water.

If the articles are to be decorated, for instance, with drawings, or ornaments in gold, silver, or bronze, this is done after the last priming, and they must also be thoroughly dry before the varnish is applied. Then the first coat of varnish is given, and in doing this care must be taken not to injure the decorations. When this coat has become *thoroughly hard*, it is gently rubbed with powdered pumice-stone, tripoli, and burnt hartshorn and felt, and then washed off. The second coat is then given. If the varnishing is also to be polished, it is, of course, necessary that the last coat should be thoroughly dry and hard, so that the polish will show a proper lustre.

The separate operations which have to be performed in varnishing will now be given.

Priming.—This consists of one or more coats of oil-paint, which must be applied according to the nature of the article. It may be laid down as a rule that the second coat should be applied in a direction opposite to that of the first; and in regard to articles of wood attention is especially drawn to the following rules: The wood should be thoroughly dry; the first coat applied should not be too thick, and is to be applied in the direction of the grain of the wood, and it should be thoroughly rubbed into the pores of the wood.

Pumicing the priming.—This is done with smooth pieces of pumice-stone and water, but for finer articles linseed oil is used instead of water. A great deal of practice is required to do this properly so that one place does not become deeper than another. The pumicing must be done not in one direction, but with a circular motion, so that all places are touched uniformly and with equal pressure. When this has been done the article is thoroughly cleansed with a soft sponge and water, and rubbed with a soft chamois skin and then dried. Rubbing with linen rags must be rejected, as a clean ground cannot be obtained with them.

Laying on the color.—This is done with a fine paint-brush, and on finer articles with a camel's-hair brush. The colors used for this purpose must be rubbed very fine, and be applied very uniformly and not too thickly. To get the layer of color as uniform as possible, it is best to go over it once more with a very fine brush. A little varnish is now generally mixed with the priming, by which as uniform a coat as possible is obtained. Of course, where more coats than one are to be given, the necessary quantity of paints *for all coats* should be prepared at one time, to avoid the possibility of getting the second somewhat lighter or darker than the first, as otherwise two kinds of ground would be formed in pumicing, by the lower coat, be it darker or lighter, shining through. As previously mentioned, all the coats must be allowed to become thoroughly dry. Then we proceed to

Pumicing the paint.—This is done with shave-grass (horse-tail) and pumice-stone. Here it is necessary to proceed with the greatest care, so that all inequalities of surface are removed, but without rubbing through the paint, otherwise the painting would have to be repeated. When the pumicing is finished, the article to be varnished is cleansed with water and dried with soft leather. It is then ready for receiving decorations, etc.

Varnishing.—First of all, the room in which this very delicate work is to be done must be entirely free from dust; much moving about in it should not be permitted, and for this reason not many workmen should work in one room, as dust will naturally be raised by their moving to and fro. The varnishes to be used, oil-varnishes as well as volatile varnishes, should be kept in hermetically closed vessels of glass, porcelain, or tin, and should be opened only while in use. Either camel's-hair brushes or bristle brushes are used for laying on the varnish. Their sizes must correspond with the articles to be varnished, but they should not be too small, so that the work may be accomplished quickly. Brushes which lose bristles should be rejected. Cleanse the brushes with oil of turpentine after they have been used, and wrap them up in paper. If a brush has become hard from varnish drying on it, it is best to throw it away, though it can be softened with oil of turpentine which has been gently heated, but it never will become as good as before, and, therefore, it should be a guiding rule to cleanse every brush immediately after it has been used.

Varnishing requires a great deal of practice and skill, and therefore general rules only can be laid down in regard to it.

Amongst these it may be especially mentioned that the work should be done quickly, that no place be touched twice, that the varnish always be laid on in one direction, that not too much varnish be taken on the brush at one time, as by doing this uneven places will be formed. Oil-varnish is laid on cold, and in a room which is not heated (of course, only during the summer), but volatile varnish is applied, either cold or warm, according as wood, paper, or metal is to be coated. In the first two cases it is laid on cold, in the latter when heated only. The volatile varnish to be used is not placed directly upon the fire, but is put in a tin vessel filled with hot water. Volatile varnish must be treated with special care, and applied to the previously heated articles in a warm room. Care must also be taken not to breathe or blow upon the article, as in such case the varnish will quickly coagulate, absorb moisture, and turn white

As previously mentioned, varnishes must not be laid on too thickly, and under no consideration in a layer of varying thickness, as blisters and wrinkles will be formed, without mentioning the fact that the work will be uneven.

Two coats of oil-varnish and three of volatile varnish are generally sufficient; but if the varnished articles are to be polished, four coats of oil-varnish and five of volatile varnish will be required. If oil-varnishes are to be polished, they must be pumiced after the application of each coat.

It must further be accepted as a rule that varnishing in the open air should be done only on clear days, and, of course, not in the sun. Fog or damp air causes the coat of varnish to turn white, or at least gives it a dull look, and the sun will blister varnish not completely dry.

Pumicing the coat of varnish.—The object of pumicing the coat of varnish is to remove any inequalities of surface which may have been formed. It will easily be understood that this is a work requiring special skill. But pumicing the coat of varnish cannot be omitted under any consideration, as the varnished article would not look well. In fact, it must be pumiced so smooth that its surface shines like a mirror.

Polishing varnishes.—Fat varnishes, to be polished, must first be pumiced with pumice-stone powdered as fine as possible. The layers of varnish are then rubbed with burnt hartshorn, or burned and prepared oyster-shells, mixed with water, until the hartshorn or oyster-shells become dry, and the varnished article shows lustre. The rubbing is done with a small pad. When this operation is finished, some suet is taken upon the pad and the article rubbed with this, and then some hair powder is used, which will remove the grease left from the suet.

The article will then have acquired a beautiful lustre. But special care must be taken to examine thoroughly the powdered hartshorn, or oyster-shells, and to eliminate any particles of sand which may have been accidentally mixed with it, as these would do great injury to the work by scratching it.

Volatile varnishes are polished in the same manner as described above.

Materials used for pumicing.—These are pumice-stone in pieces, so-called raw pumice-stone, very finely powdered, and washed pumice-stone, tripoli, emery, animal charcoal, prepared hartshorn, oyster-shells, whiting, shave-grass (horse-tail), felt, woollen cloth, leather, and linen.

Varnishing of wooden articles, carriages, and furniture.—It is necessary to observe accurately the following rules:—

Examination of the article.—The carriage or wagon, which is received from the builder, is thoroughly examined, and filling up or stopping any cracks or flaws found in the body parts constitutes the first work of the varnisher.

The varnisher prepares hot glue, takes finely-picked flax, dips this into the glue, and fills the cracks with it. It is allowed to dry thoroughly, and all the superfluous glue is then removed.

When this operation is finished, and the different parts of the body have been smoothed, the next work is proceeded with.

Soaking with linseed oil.—This is done to prevent moisture from penetrating. A uniform layer of linseed oil is applied, and as soon as the first coat has become thoroughly dry the second coat is laid on.

Puttying (filling up).—It may happen that depressions are found in the panels, and to remove them they are filled up with putty. When the putty has become perfectly dry, the priming coat is laid on.

Laying on the priming coat.—The so-called priming coat consists of a mixture of finely rubbed ochre, finely rubbed umber, linseed oil, oil of turpentine, white litharge, and copal varnish, in such proportions that the entire mass can be easily applied without being too thin. This priming coat is then laid on the body of the carriage. The first coat, when dry, is succeeded by six or seven other coats, but one coat must always be entirely dry before the next is applied. The coat may be considered dry when the finger-nail leaves no impression. Finely powdered pumice-stone is generally mixed with the last of the priming coats. This causes the coat to be granulated, and facilitates the pumicing of the article.

Then follows:—

Pumicing the ground.—This is done with porous and fibrous pumice-stone, ground smooth on one side. Several pieces, some round and some square, are required for this. Attention must be paid that the piece of pumice-stone which is used for pumicing is always sharp enough. If it does not take hold, it is rubbed with another piece of pumice-stone until it has become entirely sharp.

The greatest care must be observed in pumicing the panels that not a single place remains untouched; for this reason the pumiced place must be frequently washed off with clean water, so as to be able to observe whether it has been sufficiently pumiced, or whether the work has to be continued. The ground should become as smooth as glass, and after it has been washed off it should be thoroughly dried with chamois skin.

Ground coat (disguise coat) and its application.—This is composed of white lead, with a mixture of linseed oil and oil of turpentine, a small quantity of very fine white litharge and amber lacquer.

One or two coats of this paint are given, but it must never be laid on too thick. Here, also, the first coat must be thoroughly dry before the second is laid on.

Pumicing the disguise coat.—This is accomplished best by using very finely powdered pumice-stone and a piece of felt or cloth and water. Pumicing is continued until no more inequalities are observed in the surface, when the places are washed off with a sponge and carefully dried.

Laying on the principal color.—The color which is to be given to the carriage must be very finely rubbed together with a mixture of linseed oil and turpentine, the siccative is then added, and the paint carefully protected from dust. When it is to be used either amber varnish or copal varnish is added. Of this, three or four coats are given. But two, or, at the utmost, three coats are sufficient, if the paint is to receive a glazing. Two or three coats of glazing are laid on when the coats of paint have become thoroughly dry. The glazing used for this purpose must be very finely rubbed with fat-oil varnish, and allowed to settle, so that the upper part forms a colored varnish. Special care must be observed in laying on the glazings uniformly; and if this is done, they stand like a mirror upon the paint when they have become dry.

Pumicing the principal paint.—Shave-grass (horsetail) and very finely powdered pumice-stone are used for this purpose, and felt and powdered pumice-stone later on. The purpose of doing this is to remove all inequalities of surface which may have been formed. When all the parts have been pumiced, they are washed with clean water, and carefully dried with chamois skin.

The next work is—

Decorating and striping.—Generally this consists only of narrower or wider stripes of different colors, gold borders, and coats of arms. The paint used for striping is generally rubbed together with linseed oil and oil of turpentine, and compounded with a small quantity of finely powdered sugar of lead. It is generally laid on with the so-called drawing brush, and requires great skill and a sure hand.

For coats of arms and gold-ground the finest yellow ochre is rubbed together with a little white lead in old but entirely clear linseed oil, which must not be of too great consistency. If this mixture is applied, and allowed to dry for eighteen to twenty hours, the coating is ready for the gold.

All the decorations must be smooth and even, or they will suffer injury when the varnish is pumiced.

Laying on the varnish.—As soon as the stripes and other decorations are dry, they are wiped off with a moist chamois skin to remove any dust which may have settled upon them, and a coat of varnish is then quickly laid on. The coat is repeated two or three times. When the varnish has become somewhat dry in the shop, the carriage is brought into the air and sun, but it must be frequently turned about so that it will dry uniformly.

When the last coat of varnish is dry—

Pumicing and polishing are commenced. This is done with very finely powdered pumice-stone, and a piece of felt or chamois skin. When this has been done—

The last coat of varnish is laid on with quick, uniform strokes. This last coat is not pumiced.

Varnishing of Furniture, Cases, Instruments, etc.

Wooden articles.—The principal rule for varnishing these, is that the respective articles are pumiced and thoroughly smoothed; this may be done with pumice-stone and shave-grass (horse-tail). Then all the defective places are puttied up with a putty consisting of sawdust and glue, and what is superfluous of this is carefully removed. Then the scraper is used, and when the work has been done thoroughly, the surface is rubbed smooth with a suitable piece of pumice-stone. It is advisable to repeat the pumicing with powdered pumice-stone to prevent any place from remaining untouched, and then to go over it with shave-grass, which will make the respective places entirely smooth.

When the ground has been pumiced smooth, the following points have to be taken into consideration:—

a. If it is desired to preserve the natural color of the wood, one or more coats of varnish are laid on at once; the coat of varnish is either left as it is, or it is pumiced, and the wood receives another coat of varnish, and this last coat is polished.

b. If the articles are to be stained, one of the stains, the receipts for which have previously been given, is used for the purpose. When the stain is dry, the articles receive from four to five coats of colorless varnish, and the work is finished by polishing the last coat.

c. Wooden articles may also first be coated with glue or linseed oil, and can then be varnished with the various colored varnishes.

d. The articles to be varnished are veined, either with color prepared with size (glue-water), beer, or vinegar, or with linseed oil. These are rubbed together with a yellow, reddish-brown, brown, or other pigment, according to the natural color of the wood which is to be imitated. When the work of sizing the article is finished and the coat is entirely dry, the articles are pumiced and receive then three or four coats of varnish.

e. Sizing for mixing the color is best prepared by boiling about 2 ozs. of glue in 1 pint of water, and adding a small quantity of a decoction of garlic or wormwood. The article to be varnished receives three or four coats of this. It is claimed that a decoction of garlic or wormwood will prevent the wood-worm from attacking the articles. When the coat of sizing is dry, it is rubbed off with shave-grass. The so-called chalk ground is obtained by mixing very fine whiting with the sizing, and by laying three or four coats of this on the article. The ground is pumiced with pumice-stone and water. When all has been pumiced smooth and thoroughly cleansed, three or four coats of paint are laid on, and when this is entirely dry it is rubbed with shave-grass, cleansed, and varnished with volatile varnish.

f. The priming coat of oil-paint is put on the articles to be varnished in the following manner: The articles are first coated with hot, well-boiled linseed oil; they then receive a coat of a mixture of ochre and white lead, rubbed together with linseed oil, or, still better, with siccative, and when this is dry, are pumiced with pumice-stone and water. As soon as all places have been uniformly pumiced, a coat of the color which the article is to have is laid on. For this purpose it is best to incorporate the pigment in as fine a state as possible with good linseed-oil, to reduce it with oil of turpentine to the desired consistency, to compound it with a small quantity of copal varnish, or amber varnish, and then give a coat of it to the article in question.

When dry it is pumiced with powdered pumice-stone and felt, and then the varnish is laid on. Thicker or thinner varnish is used for this purpose according to the temperature.

Therefore, thinner varnish should be used in cold weather, and thicker varnish in warm.

Veining with oil-paint is done in the following manner: The article receives first one or two priming coats of oil-paint; this, when dry, is pumiced, and the veining is then done, either with oil-paint or water-color. The first process is easier than the last. The kinds of wood principally imitated are oak, curled maple, walnut, rosewood, and mahogany, and, of course, the ground-color to be used depends on the kind of wood to be imitated. These are—

for oak, white lead and ochre;
for curled maple, white lead and a small quantity of ochre;
for walnut, white lead and umber;
for rosewood and mahogany, burnt ochre and colcothar (Indian red).

The water-colors for veining are prepared by mixing—

for oak, umber;
for curled maple, burnt sienna;
for walnut, umber;
for rosewood, burnt sienna and umber;
for mahogany, sienna, with a little red,

with water, vinegar, or beer, and they are then laid on according to the rules of the art. The veining itself is done with a brush or sponge, wooden horn, or leather combs, and in modern times also with veining rollers made of leather or rubber and provided with the pattern of the texture of the wood; quills and even the fingers are also employed for the purpose. The varnish is laid on as soon as the veined ground is dry and has been pumiced Usually two coats are given, but the second should never be laid on before the first is entirely dry.

If the veining is to be done with oil-paint, a priming coat of water-color is first laid on, and this is rubbed in with linseed oil as soon as it has become dry. The veining is done with a camel's-hair brush, and the above-mentioned colors mixed with linseed oil.

The work is glazed as soon as the veining is dry. This is done with umber, sienna, crimson-lake, or even carmine-lake, for very fine articles. The articles are then varnished, but not before the glazing is dry.

Lacquering Articles of Tin and Other Metals.

The lacquering of tin and other metals differs from that of wood. The first require far fatter varnishes than the latter. They are dried in especially constructed ovens (lacquering ovens).

The usually *rough articles of tin* must be thoroughly smoothed and pumiced before they can be lacquered, when they receive a coat of linseed oil, and are thoroughly dried by a strong heat. They then receive four or five primary coats, are again thoroughly dried, and then pumiced with pumice-stone and water until the surface is as smooth as a mirror. When these important operations have been finished the principal color is laid on. This is rubbed together with linseed oil and oil of turpentine, and compounded with copal varnish. The articles receive at least three or four coats of this, but every coat must be thoroughly dry before the next one is laid on. When the last coat has become as hard as stone the article is pumiced with powdered pumice-stone and shave-grass, the various decorations are put on and allowed to dry, and the article is then varnished with copal varnish. When this coat is dry the article may be pumiced with powdered pumice-stone and felt; it is then thoroughly cleansed and carefully dried, and finally receives one or two coats of varnish. It is absolutely necessary that all the described operations should be carried on with the greatest care.

What has been said of tin-ware applies in general also *to articles of iron and steel*, only they require less preparation. When they are ground smooth and polished, it is only necessary to give them a coat of oil-varnish, which is allowed to dry hard, and then the same process is carried on as has been described for tin-ware.

Articles of copper, brass, and zinc require a fat, pliant varnish, and specially careful treatment. As most of these articles are soldered and possess more or less fatty matter, the first care must be to free them from this. This is done by thoroughly rubbing the articles with sawdust. They are then cleansed and treated with fat and well-drying paints and varnishes, and dried at a moderate degree of heat. Pumicing and cleansing are done in the same manner as has been described for tin-ware.

The colors mostly used in lacquering the above-named wares are—

Black.—This color is produced either by giving the article a coat of fine calcined lampblack mixed with linseed oil, or by giving it at once a coat of asphaltum varnish. For common articles the ordinary asphaltum varnish may also be used to advantage upon iron, copper, zinc, etc. Both methods are good, and the coats dry quickly.

Brown is produced by laying on a priming coat of Venetian red mixed with a small quantity of calcined lampblack. When dry it receives a coat of glazing.

Red.—A mixture of cinnabar, linseed oil, and oil of turpentine is prepared for this, and mixed with a small quantity of copal varnish. The article receives from three to four coats of this, is thoroughly dried, and then glazed. The glazing is prepared by rubbing fine carmine-lake with linseed oil and oil of turpentine, and mixing it with some copal varnish. This is allowed to stand quietly for a few days. The liquid part is then poured off from the sediment, and the painted articles are coated quickly and uniformly. Usually two or three coats are required according as the color is to be light or dark. Strong heat must be used for drying the articles, as the glazing is difficult to dry. When it is thoroughly dry it is pumiced and then varnished.

Green is produced with mineral green. The treatment is the same as given for red, only green is frequently mixed with yellow and white. The articles to be lacquered receive first a white priming coat. Dark green is prepared with Naples green and glazed with verdigris. This color should *not* be exposed to a great heat.

Yellow, chamois.—By chamois-yellow is meant a mixture of white, yellow, and red. Chrome-yellow also does excellent service for yellow. Two or three coats are sufficient.

Blue.—A mixture of Paris blue and white, or ultramarine and white, is used for a blue priming coat, according as the color is to be light or dark. It is glazed with either Paris blue, ultramarine, or cobalt blue (Thenard's blue).

Other colors are treated in the same manner. A few coats are generally sufficient for covering, and it is then only necessary to lay on the lacquer.

Marbled ground is produced by pumicing the articles, which have first received a black priming, by rubbing them with oil of turpentine, and exposing them to heat. Then a sharply cut bristle brush is soaked with oil of turpentine, and the hot articles are sprinkled with it. It is advisable to hold the articles at some distance to prevent the fine drops from falling upon them. The drops falling upon the article scatter and form a ring on the edge. Gold or silver bronze is laid upon these rings before they become entirely dry. What is superfluous is rubbed off after they have become dry.

Tortoise-shell ground is produced by giving the article a one-colored ground of vermilion, or any other fine brown-lake. When this coat is dry it is pumiced and glazed with carmine-lake. The following method is then observed: The wick of an oil-lamp is screwed up higher than usual, so that it commences to smoke, and more or less dark places are produced upon the still wet glazing by holding the article over the wick of the lamp and turning it to and fro. When the desired spots have been produced in this manner, pumicing is commenced, and the article is then varnished.

Rosewood ground is imitated by giving the article, upon which the ground is to be imitated, a priming coat of calcined lampblack. This is allowed to become thoroughly dry, and is then pumiced. On the other hand, a paint of Venetian red and carmine-lake, or vermilion and carmine-lake, is prepared with linseed oil, and the article is veined with a brush according to a sample of a polished piece of rosewood. When this is dry it is glazed with carmine-lake, varnished and pumiced.

Decorations with copperplates and lithographs.—The apparatus consists of a plate, which is etched for reprinting. When the apparatus is prepared, the following method is observed:—

First a printing ink of linseed oil is prepared, which is mixed with Frankfort black. The ink must possess great consistency. The plate is heated and some of the ink is put uniformly upon the etched parts with the finger; the greater part of the ink is wiped off, and the plate is cleansed with lye. When this has been done the plate is brought into the press, a previously moistened paper is laid upon it, this is covered with a cloth folded several times, and then drawn through the press. The paper is then carefully removed, moistened with water, and laid upon the article. The impression of the copperplate is imprinted upon the article by a small roller covered with cloth, and the paper is then removed.

The same manipulation is used for *lithographs*.

Bronze-painting is done with metal-dust, genuine gold leaf, silver bronze and gold bronze, mostly upon black ground. Parisian camel's-hair pencils are used for the purpose; the bronze is rubbed in with a piece of felt upon the previously prepared ornamentation. Patterns cut out of oiled paper are used for the decorations. Genuine leaf gold is laid upon the varnished places while still moist. All these operations require great skill, and this the workman can only acquire by constant practice.

Varnishing of leather differs essentially from that of tin-ware and articles of metal. One of the main points is to use a pliant varnish which will stand being bent in any way, will neither break off nor crack, and yet possess the necessary degree of hardness.

The outside of the leather to be varnished must have been well finished and rubbed with train oil. It is then stretched upon a frame, somewhat moistened and pumiced, and smoothed with a piece of pumice-stone and with pumice powder.

When the leather is dry, a coat of varnish, made of linseed oil, is laid on. The manner of preparing this varnish, which is generally done by the workman himself, has been fully described under "blue lacquer."

Simple Process of removing a coat of Varnish, etc., from Tinned Metal Plate.

BY D. H. EMSMANN, OF STETTIN.

About twenty-five years ago, I accidentally brought a varnished tin box in contact with leather through which mercury had been pressed, and found, to my surprise, that the varnished surface of the box came off in its entirety in the form of a delicate leaf. I was sorry that I had damaged the beautifully ornamented box, but as it had been already injured, I experimented also with the remaining surface, and succeeded in removing everywhere the coat of varnish without tearing it.

The explanation of this phenomenon was simple. The box was made of tinned sheet-iron, and the coat of varnish had been partly broken off on the edges; the mercury remaining on the leather had formed an amalgam with the tin; a fluid layer had been formed between the surface of the iron, and in consequence of this the leaf of varnish, floating, so to say, upon the fluid, could be removed with the greatest ease.

The question now arose, whether this phenomenon could be used to advantage in any manner, and several experiments were made for this purpose. I painted tinned sheet-iron with oil-varnish, and in doing this I handled the brush always in one direction. When this coat of varnish had become dry, in a few days, I laid on a second coat in a direction crossing the first at a right angle. When this coat had become dry a cut was made with a knife through the varnish down to the tin, and some mercury was dropped on this; the entire layer of varnish came off, and showed a parchment-like smooth surface on the side which had touched the tin.

When the mercury had evaporated I again put a coat of oil-varnish on the same tin, and repeated the operation in the above described manner until a layer about 0.039 inch thick had been formed. This required quite a considerable time on account of the varnish drying but slowly. I obtained, however, a plate like strong leather, with a surface as smooth as a mirror.

From the obtained leather I cut rectangular triangles and rulers for mathematical instrument cases. But as these were not very solid, but rather brittle, I stretched a sheet of paper over a frame, and coated it repeatedly on both sides in the above-mentioned manner, and obtained in half the time sheets of any desired thickness, which, on account of the enclosed paper, proved to be more suitable for the indicated purpose, but had not so smooth a surface.

This matter may now be inquired into further, as by this short statement I only intend to incite to further researches.

Very likely leaves of any desired size and thickness, and of various substances, can be produced in this manner, which may prove especially useful for certain purposes. Paper covered on both sides with a layer of oil-varnish, and then coated with size, answers all the purposes of parchment. It is possible that a substance might in this manner be prepared which, in many cases, could be used as a substitute for leather.

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